January 15, 1935.

UNITED STATES DEPARTMENT OF AGRICULTURE

Bureau of Entomology and Plant Quarantine

RESULTS OF CODLING MOTH INVESTIGATIONS, 1934

Not for Publication

Part I

Work Conducted by State Agencies

ARKANSAS

Dwight Isely, Arkansas Agricultural Experiment Station, Fayetteville.

I. The codling moth was less injurious in Arkansas during 1934 than for a number of years, probably since 1929. The season was notable for a very severe drought - more severe in the apple belt of Arkansas than in 1930 - and by consistently high temperatures from May to September.

II A. (In spraying experiments the same schedule was followed on all plots, a calyx spray and seven cover sprays. Arsenate of lead was used in all plots in the calyx spray and in the first four cover sprays. In a number of plots substitutions were made in the three last sprays.)

Lead arsenate used with a fungicide gave better results than in 1933, yielding 12.59 percent wormy fruit at harvest in comparison with 29.13 in 1933. When a white oil was added to the spray mixture from the second cover spray until the last only 2.81 percent of the fruit was wormy.

Calcium arsenate, substituted for arsenate of lead in the last 3 cover sprays, gave unsatisfactory results, 25.20 percent of the fruit being wormy.

The only organic material used as an arsenical substitute was a stable nicotine. In a plot where 5 applications of this material made at 10-day intervals were substituted for 3 arsenate of lead applications, the harvested fruit was 27.03 percent wormy.

More spray burning occurred on the arsenate of lead-oil plots. The best finished fruit was from the plots on which nicotine was used.

II B. Where chemically treated bands were used experimentally, a complete kill of all worms which entered the bands or crawled under them appeared to be secured. The degree of control obtained was not checked.

Winter sanitation was used extensively by growers, but there was no check on its efficiency.

III A. No experiments with residue removal were carried on.

III B. During the past storage season growers experienced considerable difficulty with washed fruit where the washing solution had been heated.

CALIFORNIA

A. D. Borden, California Agricultural Experiment Station, Berkeley.

I. Seasonal conditions and codling moth abundance:

Following a mild, open winter (1933-34) the spring emergency of codling moth was unusually early and abundant. High peaks of emergence are noted as early as March 25-26 and March 29 to April 9, which is several weeks earlier than normal. Fruit bud development was correspondingly early.

Our bait trap records indicate an abundance of moth throughout the season with a heavy attack on late varieties of fruit. Heavy calyx sprays proved most effective as well as timely second-brood applications. Poorly sprayed and insufficiently sprayed orchards show heavy losses.

II. Results of experimental work:

A. Control by insecticides:

Over 30,000 gallons of dilute spray applied on 55 plots (apples and pears) in four counties.

(1) Lead arsenate gave the best control in all experiments. Lead-oil, lead-blood albumen and lead-fluxit gave the maximum control. Blood albumen is the best spreader on pears.

Standard Lead Arsenate Sprays

Dosage	Spreader	on	Number Applications	Percentage wormy fruit**
*4-100	None	Pear	4	1.6
	1 gal. Oil	"	4	1.3
	3/4# Fluxit No. 1	"	4	1.7
	6 oz Blood	"	4	1.5
	1 qt Orthoex	"	4	4.4
Check	------	"	None	34.8
*3-100	None	Pear	4	20.7
	1 gal. Oil	"	4	15.0
	3/4# Fluxit No. 1	"	4	15.8
	6 oz Blood	"	4	11.8
	1 qt Orthoex	"	4	41.4
	1/2# G W Soap	"	4	33.4
Check	-------	"	None	51.4

* Not on the same orchard.

**All fruit from four center trees in a 16-tree plot was counted.

(2) Non-lead Arsenicals

Material	Dosage	On	Number Applications	Percentage wormy fruit
Calcium arsenate	2½ lb - 100	Pear	4	43.7
Lead arsenate	3 lb - 100	Pear	3	
Calcium arsenate	2½ lb - 100	"	2	14.6
Manganese Ars.	3 lb - 100	Pear	4	35.4
Lead arsenate	3 lb - 100	Pear	3	
Manganese Ars.	2½ lb - 100	"	2	14.4
Lead arsenate	3 lb - 100	Pear	4	15.8
Fluxit	3/4 lb - 100	"		
Check	None	Pear	None	34.8
Calcium arsenate	2½ lb - 100	Apple	5	23.0
Manganese ars.	3 lb - 100	Apple	5	6.6
Lead arsenate	3 lb - 100		3	
Oil-nicotine	1 gal-5#-100	Apple	2	2.7
Check	------	Apple	None	40.2

Heavy defoliation in last three sprays with Manganar.
Light defoliation with calcium.

(3) Fluorine Compounds

Material	Dosage	On	Number Applications	Percentage wormy fruit
Lead arsenate	3 lb - 100	Apple	1	
Dutox	3 lb - 100	"	4	7.2
Nat. Cryolite (Kalo)	3 lb - 100	Apple	5	7.3
Syn. Cryolite	3 lb - 100	Apple	5	21.2
Check	------	Apple	None	40.2

Some defoliation with Dutox in last spray (coastal).

(5) Organic materials:

Oil-Black Leaf 40 as late sprays on pears and apples has been insufficient to give control of late worms where applications were made approximately a month apart.

Oil-nicotine bentonite has shown some promise as a late spray on apples and pears.

B. Control by means other than spraying:

(1) Bands

(a) "Hot dip" chemically treated bands very effective on apples when rough bark is removed. Not so practical on pears. Banding of upper scaffold on limbs on apples caught more worms than trunk bands.

(3) Bait trap studies over a period of six years show a remarkable uniformity of emergence peaks throughout northern California.

Bait traps in walnuts indicate a very high population for the amount of injury to nuts. It is believed that feeding and maturity is largely attained on the foliage.

III. Residue and its removal:

A. Results of experiments with residue removal.

(1) The past season we have taken leaf and fruit samples before and after each spray application, fruit samples at harvest and after treatment on the 55 spray plots we conducted. This includes studies on several varieties of apples and Bartlett pears on which lead arsenate with various spreaders, non-lead arsenicals and fluorides were applied. As soon as these data are completed they will be published as a technical paper.

(a) Solutions used: Packers have used cold water washes with from .6 to 1.5% sulphuric acid on all late apples and pears. Gravenstein apples are only run through wiping machines (7 roll Andy Moe). No difficulty has been met in keeping under the tolerance except a few cases where yellow Newtown apples or other waxy varieties have remained in the field several weeks before treatment. Late applications of oil-lead arsenate on rough-skinned varieties of pears has proven difficult.

(b) There has been a marked increase in the number of washers in this State the past season, so that now nearly every packing plant is equipped. Many different types are in use.

(c) Heating of solution rarely used.

B. Comparatively few growers are equipped as most of the fruit is handled through cooperative or commercial packers.

IV. Recommendations proposed for 1935:

Similar to last season's with emphasis on building up a load early in the season and tapering this off in late sprays.

More attention to banding and control of overwintering larvae.

COLORADO

J. H. Newton and George M. List, Office of State Entomologist, Fort Collins.

The work has been confined largely to the operation of bait traps in the principal producing sections, to determine the activity of the moths, and in experimental spray work at Paonia, Delta County. The records from the bait traps have been used as the basis for all spray dates.

The codling moth infestation proved to be heavier than usual in most localities and the moths appeared earlier than ever recorded. The first moths were flying at Paonia April 21, which is three weeks earlier than the earliest record. This was 35 days earlier than for the season of 1933. In the experimental orchard where traps have been operated on the same trees for the past four seasons, the same number of traps caught 6,227 moths, while for the other years the catch was as follows: 1933, 2,078; 1932, 3,546; 1931, 3,639. The catch for the first brood alone was equal to the total season's catch of 1932. There was a distinct third brood in this locality this year. The season in the Grand Valley was very much advanced and the infestation proved to be heavy with serious losses resulting.

The experimental control work was carried in the Ernest Allen orchard at Paonia, which has been under our control now for the fourth season. A total of 33 plots was used. In practically all cases, by making use of the way the varieties were interset, it was possible to have duplicate records on each test for the varieties of Delicious and Rome Beauty. Each plot consisted of from 9 to 14 trees, with the standard which was used as the check so arranged that all that were compared with it were adjacent. The standard treatment, which in the tables that follow is designated as A, consisted of a calyx spray and 7 cover sprays of lead arsenate, to which lime was added at the rate of 2 ounces to 100 gallons. The hydrated lime reacted with casein present in the arsenate of lead used to form a calcium caseinate spreader. Three pounds of arsenate of lead were used to 100 gallons for the calyx application and the first three cover sprays. In the four remaining cover sprays 2 1/2 pounds were used. The object in using the small amount of lime was to form just enough lime caseinate to act as a spreader without unnecessary runoff. With hard water slightly more lime would be necessary. The calyx application in all plots was with lead arsenate. Where nicotine sulfate was used it was at the rate of one pint of Black Leaf 40 to 100 gallons. Summer oil was used at the rate of 1 gallon to 100 gallons. The special oil in plot K was used at the rate of 1 percent and on plot X it was used at the rate of 1/2 percent. All cryolite was used at the rate of 3 pounds to 100 gallons with 1/2 percent summer oil where oil was used in the combination. Cupric cyanide (Kutane) was used at the rate of 3 pounds to 100 gallons. The tables give the principal results from these tests. All plots having the same letter are duplicates. Throughout the season samples of fruits were taken before and after each cover spray and the load of arsenate of lead determined on the basis of micromilligrams per square inch. Samples were also taken immediately before harvest and analysis made and again after the fruit had been washed. Only the results of the arsenic load after washing are given as the data are too voluminous. The lead residue present after washing is being determined but is not available at this time.

Harvest and Windfall Counts Codling Moth Experimental Plots, Paonia, Colo., 1934

Delicious

Schedule	Total fruit	% free fruit	% wormy fruit	% stung fruit	% injured compared with standard: Total	Wormy	Stung	Arsenical residue
A. Standard = calyx plus 7 cover sprays lead arsenate plus lime	6279	81.25	2.73	16.02				.006
A1 Replicate	4863	79.81	2.46	17.73				.003
B. Standard plus B.L. 40 and 1% summer oil in 2d & 5th. cover sprays	6030	88.75	1.84	9.41	-7.5	-0.89	-6.6	.007
B1 Replicate	5603	85.40	1.82	12.78	-5.59	-0.64	-4.95	.010
C. Standard, 3d. cover omitted	5283	64.55	6.02	29.43	+16.7	+3.4	+13.39	.006
C1 Replicate	5811	66.76	7.49	25.75	+13.05	+5.03	+ 8.02	.006
D. Standard plus 1% oil in 2d. and 3d. cover sprays	9161	83.18	2.80	14.02	-1.93	+0.07	-2.00	.01
D1 Replicate	7709	85.07	1.63	13.30	-5.26	- .83	-4.43	.008
E1 Cryolite (Kalo) 3 to 100- 7 cover sprays	5307	63.10	11.49	25.41	+16.71	+9.03	+7.68	
F. Cryolite (Kalo) 3 to 100 plus ½% oil-7 cover sprays	6155	83.80	3.39	12.81	-2.55	+0.66	-3.21	
F1 Replicate	5120	77.74	6.97	15.29	+2.07	+4.51	-2.44	
G. Standard (Special lead arsenate) no lime-spot coverage	5716	75.17	5.88	18.95	+6.08	+3.15	+2.93	.007
M. Standard (no lime) spot coverage	4675	73.46	8.31	18.23	+7.79	+2.21	+5.58	.005
MX Standard minus last cover spray (Compare with M.)	2909	70.53	8.10	21.73	+2.93	-0.21	+3.14	.004

Harvest and Windfall Counts Codling Moth Experimental Plots, Paonia, Colo. 1934.

Rome Beauty

Schedule	Total fruit	% free fruit	% wormy fruit	% stung fruit	% injured compared with standard Total	Wormy	Stung	Arsenical residue
A2 Standard = Calyx plus 7 cover sprays lead arsenate plus lime	3063	41.11	21.51	37.28				.007
A3 Replicate	3144	38.26	17.41	44.33				.005
B2 Standard plus B.L. 40 and 1% oil in 2d. & 5th. cover sprays	4015	63.68	28.18	28.14	-22.57	-13.33	- 9.24	.004
B3 Replicate	2680	44.83	21.97	33.20	- 6.57	+ 4.56	-11.13	.004
C2 Standard, 3d. cover omitted	1620	63.21	10.93	25.86	-22.10	-10.58	-11.42	
C3 Replicate	2928	21.42	30.70	44.88	+16.84	+16.29	+ 0.55	.003
D2 Standard plus 1% oil in 3d. and 5th. cover sprays	3608	59.21	13.78	27.01	-18.10	- 7.73	-10.37	.01
D3 Replicate	4160	64.79	7.59	27.62	-26.53	- 9.82	-16.71	.005
E2 Cryolite (Kalo) 3 to 100, 7 cover sprays	2704	55.26	16.58	28.16	-14.15	- 4.93	- 9.22	
E3 Replicate	4298	34.75	31.03	34.22	+ 3.51	+13.62	-10.11	.005
F2 Cryolite (Kalo) 3 to 100 plus ½% oil, 7 cover sprays	4086	78.19	7.01	14.80	-37.08	-14.50	-22.58	
F3 Replicate	957	69.58	7.36	27.29	-27.09	-10.05	-17.04	
H Standard (Special lead arsenate with lime) smooth coverage	3226	52.49	20.06	27.45	- 9.09	+ 0.59	- 9.68	.004
I Standard	2299	43.40	19.47	37.13	Compare H and J			.004
J Standard (Special lead arsenate) spot coverage	1664	43.74	26.01	30.25	- 0.34	+ 6.54	- 6.88	.005

Rome Beauty (continued)

Schedule	Total fruit	% free fruit	% wormy fruit	% stung fruit	% injured compared with standard: Total	Wormy	Stung	Arsenical residue
A2 Standard for following plots		41.11	21.51	37.38				.007
K1 Standard plus special oil in 2d. cover spray	3169	58.01	11.25	30.74	-16.9	-10.26	-6.64	.004
K2 Standard plus special oil in 2d. & 5th. cover sprays	2134	58.87	8.94	32.19	-17.76	-12.57	-5.19	.006
L Standard plus lime (8 oz. to 100 gals.)	1569	58.05	14.08	27.87	-16.94	- 7.43	-9.51	.003
MX Standard minus last cover spray	3152	50.30	25.46	24.24	- 9.19	+ 3.95	-13.24	.004
N Cryolite (Synthetic)	3185	67.52	16.81	15.67	-26.41	- 4.70	-21.71	

Grimes Golden

Schedule	Total fruit	% free fruit	% wormy fruit	% stung fruit	Total	Wormy	Stung	Arsenical residue
B2 Standard plus B.L. 40 and 1% oil in 2d. & 5th. cover sprays	3156	65.35	7.36	27.29	(Check for O and X)			
O Cupric cyanide (Kutane)	3517	44.87	18.99	36.14	+20.48	+11.63	+8.85	
X Arsenate of lead for calyx and 3 cover sprays, then 4 cover sprays with special oil only	1975	20.06	53.87	26.07	+45.29	+46.51	-1.22	

Summary of Control on Delicious

The best data were secured from the Delicious plots as the crop here was very uniform and medium to heavy. The percent of injured fruit on the standard plots in the two series was practically identical. The following statements of results seem justified from the data:

(1) The use of nicotine sulfate and summer oil emulsion in combination with lead arsenate at the peak of egg laying of each brood (2d and 5th cover sprays) resulted in slightly less wormy fruit in each of the duplicate blocks and 4.95 percent and .61 percent less stung fruit.

(2) Summer oil emulsion in combination with lead arsenate (2d and 5th cover sprays) resulted in slightly less wormy fruit on each of the duplicate blocks and 2 percent and 4.4 percent less stung fruit.

(3) Omission of the third cover spray (last cover spray for first brood of larvae) resulted in 13.05 and 16.70 percent more injured fruit on the duplicates.

(4) Cryolite (Kalo) in the cover sprays, without oil as a sticker and spreader, gave 16.71 percent more injured fruit than the standard. This consisted of 9.03 percent more wormy fruit and 7.68 percent more stung fruit.

(5) Cryolite (Kalo) used in the cover sprays with .5 percent summer oil emulsion gave approximately the same percent of injured fruit as the standard and 1.5 and 4.5 percent more stung fruit.

(6) A special lead arsenate in spot coverage without the caseinate spreader, gave control slightly below the standard.

(7) The standard lead arsenate with a spot coverage without the spreader gave control slightly below the standard with the spreader.

(8) Omission of the last cover spray (seventh) resulted in an increase in injured fruit.

Summary of Control on Rome Beauty

On account of fire blight and other factors the Rome Beauty crop was uneven and probably did not average over one-half of normal. For this reason the results are hardly as reliable as those on the Delicious. It will be noted that the standard plots do not show as uniform results as with the Delicious. The following statements will bring out some of the more important indications.

(1) The standard schedule plus nicotine sulfate and 1 percent oil at the peak of egg laying of each brood (2d and 5th cover sprays) gave 6.5 and 22.5 percent less injured fruit on the two plots.

(2) The standard schedule plus 1 percent oil in the 2d and 5th cover sprays gave 18 and 26.5 percent less injured fruit.

(3) Omission of the third cover spray (last cover spray for first brood) resulted in 16.8 percent increase of injured fruit.

(4) Cryolite (Kalo) without oil gave slightly less injured fruit in one plot but there was 13.62 percent more wormy fruit in replicate.

(5) Cryolite (Kalo) with oil gave 27 and 37 percent less injured fruit in the two plots. In one plot this consisted of 10 percent wormy fruit and 17 percent stung fruit, while in the other block it consisted of 14.5 percent wormy fruit and 22 percent stung fruit.

(6) Special lead arsenate with caseinate spreader (smooth coverage) gave 9.6 percent less stung fruit than did the standard.

(7) Special lead arsenate without spreader (spot coverage) gave 6.5 percent more wormy fruit than the standard.

(8) The regular lead arsenate plus special oil in 2d cover spray resulted in 16.9 percent less injured fruit.

(9) Regular lead arsenate plus special oil in 2d and 5th cover sprays resulted in 17.76 percent less injured fruit.

(10) The standard schedule with last cover spray omitted resulted in 3.95 percent more wormy fruit.

(11) Cryolite (synthetic) with oil resulted in 26 percent less injured fruit.

(12) Cuprous cyanide (Kutane) used in six cover sprays on Grimes Golden gave 20.48 percent more injured fruit than did the standard schedule.

(13) In block X where the standard arsenate of lead was used on the calyx spray and the first brood cover spray with three sprays of the special oil for second brood control, the injured fruit increased 45.29 percent over the standard plot.

DELAWARE

L. A. Stearns, Delaware Agricultural Experiment Station, Newark.

I. Seasonal conditions and codling moth abundance during the 1934 season.

The general codling moth situation in Delaware, during 1934, showed considerable improvement over the conditions reported for the years 1930-1933. This was especially true in the case of the Bridgeville district in Sussex County, wherein a noticeably higher percentage of the harvested crop was free from worm injury. In Kent County, severe infestation was restricted, as in previous years, to well-defined areas and to certain, somewhat isolated plantings as well. The unusual control difficulties experienced therein, during the past five years, are the result of inefficient orchard management and spraying procedure, which had already permitted the development of a high codling moth population. As usual, the codling moth occasioned little concern in the old, comparatively small, and scattered orchards of New Castle County.

Several factors were responsible for the decrease in the population of this insect during 1934. Weather conditions, during the spring, were less favorable for first brood activity. Certain growers had located their individual difficulties and had effected the changes in orchard management and spraying procedure necessary to insure more effective control. With spray residue tolerances for the 1934 crop definitely established in the announcement dated December 12, 1933, orchardists were able to face the season ahead

with an assurance concerning regulations, in marked contrast to the more or less hectic conditions prevailing during 1933. There was, therefore, less worry concerning the prospects of harvest residue, a more general reliance upon the standard lead arsenate treatment, and but a slight inclination to employ substitute materials of questionable efficiency. Finally, the recommended program of applying supplementary control measures, especially scraping and banding, was again followed, especially by certain orchardists whose combined plantings in apple comprise a considerable percentage of the total acreage in the districts primarily concerned.

II. Results of experimental work.

A. Control by insecticides.

(Orchard spraying plots (30) were of from 12-14 trees each; unusually severe conditions of infestation; additional materials - dritomic sulphur (6 lbs.) and hydrated lime (6 lbs.) per 100 gals. of spray in petal fall application and Bordeaux (2-4-100) in all cover sprays; 30,000 apples (1000 per plot) graded for results included herein-after).

(1) Lead arsenate.

(a) Lead arsenate (3 lbs.) only in petal fall and six cover sprays (three for each brood) - 10.0% wormy, 62.3% U.S. No. 1, 22.2% U.S. Utility, 15.6% Unclassified, total seasonal population averaging 27.85 larvae per tree.

(b) Lead arsenate (3 lbs.) in petal fall and six cover sprays, with summer oil (1 gal.) in 2nd and 3rd covers - 11.2% wormy, 57.9% U.S. No. 1, 22.8% U.S. Utility, 19.3% Unclassified, total seasonal population averaging 13.65 larvae per tree.

(c) Lead arsenate (3 lbs.) in petal fall and six cover sprays, with summer oil (1 gal.) in 2nd. 3rd, 5th and 6th covers - 10.8% wormy, 54.0% U.S. No. 1, 24.8% U.S. Utility, 21.2% Unclassified, total seasonal population averaging 5.6 larvae per tree.

(2) Non-lead arsenicals (performance of Manganar far exceeded that of all others, including calcium, zinc and magnesium arsenates).

Manganar (3 lbs.) in petal fall and six cover sprays, with summer oil (1 gal.) in 2nd and 3rd Covers - 19.6% wormy, 34.7% U.S. No. 1, 30.1% U.S. Utility, 35.2% Unclassified, total seasonal population averaging 24.7 larvae per tree.

(3) Fluorine compounds.

(a) Kalo (3 lbs.) in petal fall and six cover sprays, with summer oil (1 gal.) in 2nd and 3rd covers - 37.1% wormy, 45.9% U.S. No. 1, 13.8% U.S. Utility, 40.3% Unclassified, total seasonal population 109.4 larvae per tree.

(b) Kryocide (3 lbs.) in petal fall and six cover sprays, with summer oil (1 gal.) in 2nd and 3rd covers - 42.6% wormy, 46.4% U.S. No. 1, 9.0% U.S. Utility, 44.6% Unclassified, total seasonal population 104.75 larvae per tree.

(4) Other inorganic materials.

(5) Organic materials.

(a) Oil-Nicotine.

Lead arsenate (3 lbs.) in petal fall and first four cover sprays with summer oil (1 gal.) in 2nd and 3rd covers; nicotine (1-800) and summer oil (1 gal.) in 5th and 6th cover sprays - 19.3% wormy, 57.4% U.S. No. 1, 19.6% U.S. Utility, 23.0% Unclassified, total seasonal population 36.35 larvae per tree.

(b) Nicotine-Tannate.

(c) Derris.

(d) Pyrethrum.

(e) Other organic materials (fixed nicotine compounds) (E-1) Black Leaf #155: lead arsenate (3 lbs.) in petal fall and 1st cover spray; Black Leaf #155, (5 lbs.) and summer oil (1 gal.) in all (5) other cover sprays - 31.8% Wormy, 52.9% U.S. No. 1, 14.8% U.S. Utility, 32.3% Unclassified, total seasonal population 121.15 larvae per tree. (E-2) Black Leaf #155-BX: lead arsenate (3 lbs.) in petal fall and 1st cover spray; Black Leaf #155-BX (5 lbs.) and summer oil (1 gal.) in all (5) other cover sprays - 25.3% Wormy, 59.6% U.S. No. 1, 13.8% U.S. Utility, 26.6% Unclassified, total seasonal population 154.8 larvae per tree.

Since 1933, thru cooperative arrangements effected with the DuPont Company, of Wilmington, and certain of its subsidiaries, more than 500 compounds, prepared in their chemical laboratories, have been subjected to extensive tests with the codling moth and other insects. As expected, the majority of these materials were discarded within a short time; several have shown considerable efficiency, but conditions (primarily cost) prohibited their further development; a few, whose performance in the laboratory has consistently equalled or exceeded that of lead arsenate, have not received, as yet, adequate test under orchard conditions. Indications to date, however, have been such as to suggest that research in this field may eventually be productive of results.

Note: The only conclusion that can be drawn from this work and the only recommendation that can be based upon it is: Spray frequently and thoroughly with lead arsenate and remove the inevitable residue by washing.

B. Control by means other than spraying.

(1) Bands.

Approximately 700 acres were scraped and banded during 1934. Because of the necessity of curtailing production costs, there has been a constant decline in the application of this supplementary control measure since the season of 1931.

(a) Chemically treated.

Use declined considerably (see above) (question of expense). Three types in use - "Cod-O-Cide"; Rice, Trew and Rice; and Sears, Roebuck & Co.

(b) Untreated.

Use about equal to 1933.

(2) Sanitation.

As in 1933, recommendations generally and fairly well adhered to.

(3) Bait trap studies.

Bait traps used by the Department thruout the season for securing records of moth emergence and activity; this information supplemented that recorded by means of emergence cages.

(4) Light traps.

(5) Parasite control.

No parasites reared from 23,792 band-collected larvae from experimental orchard.

III. <u>Residue and its removal</u>.

A. Results of experiments with residue removal (<u>Little data</u>)

(1) Removal of lead and arsenic.

(a) Solutions used (Acid only).

Pb before washing	= 0.060	average 4 samples			
" after "	= 0.0145	"	"	"	
As_2O_3 before "	= 0.026	"	"	"	
" after "	= 0.0065	"	"	"	

(Fruit had been sprayed with flotation sulphur or Bordeaux in combination with lead arsenate (4 lbs.) in petal fall application and five cover sprays)

(b) Type of machinery (Wayland).

(c) Heating of solutions (Unheated).

(2) Removal of fluorine compounds.

(a) Solution used.

(b) Types of machinery.

(c) Heating of solutions.

B. Growers' experiences with residue removal.

(1) Proportion of acreage equipped for washing (Still very small).

(2) Types of machinery in use.

Eight washing machines in operation, during 1934 (as compared with five, in 1933); five Bean and three Wayland, one Bean and one Wayland doing a small amount of community washing.

(3) Degree of success in residue removal.

(a) Lead and arsenic (Satisfactory to my knowledge).

(b) Fluorine.

IV. Recommendations proposed for the 1935 crop season.

Lead arsenate (4 lbs. per 100 gals. of spray) in the petal fall application and in five cover sprays spaced (tentatively) 10, 20, 30, 40 and 60 days thereafter; if a compatible fungicide is used, summer oil (1 gal. per 100 gals. of spray) may be included in the 20, 30 and 40 day covers; residue to be removed by washing.

Continued emphasis upon sanitation and supplementary control measures, especially scraping and banding.

- - - - -

IDAHO

Paul L. Rice, R. W. Haegele, and Claude Wakeland, Idaho Agricultural Experiment Station, Parma and Moscow.

Field experiments with various materials were carried on at Fruitland, Idaho. The spray schedule included the calyx application, on April 18, and eight cover sprays, on April 26; May 11 and 21; June 2, 16, and 30; July 16, and August 1. The materials used, and the results obtained are given in the following table:

CODLING MOTH SPRAYING EXPERIMENTS, FRUITLAND, IDAHO, 1934

Comparison of Percentages of Injured and Free Dropped and Picked Apples from Each Plot with the Average Percentages of the Two Adjacent Check Plots.

Plot No.	Treatment	% Wormy Apples	No. of Worms per 100 Apples	No. of Stings per 100 Apples	% Apples Free From Injury	Rating of Plot*
1	Lead arsenate, 2 lbs. per 100 gallons in all sprays	21.0	29.3	54.1	49.8	
2	Lead arsenate, 3 lbs. per 100 gallons in all sprays	9.8	21.4	37.7	64.8	129.9
1	L.A. 2-100 in all sprays	16.2	21.7	42.8	58.9	
3	L.A. plus Grandpa Soap, 1/2 lb.-100 in all covers; L.A. in C.	9.3	11.7	31.8	68.8	116.6
1	L.A. 2-100 in all sprays	12.1	15.4	33.5	65.8	
4	L.A. plus Fish oil, 1 pint-100 in all covers; L.A. in C.	8.5	11.0	30.8	69.2	105.0
1	L.A. 2-100 in all sprays	9.8	11.9	28.2	70.2	
5	L.A. plus #6 oil at 0.8% in 1-2; L.A. in C.-3-4-5-6-7-8.	5.8	7.0	18.0	80.6	114.6
1	L.A. 2-100 in all sprays	8.2	9.8	23.5	75.4	
6	L.A. plus E-548 oil at 0.8% in 1-2; L.A. C - 3-4-5-6-7-8.	8.8	11.0	18.0	77.7	103.1
1	L.A. 2-100 in all sprays	10.8	13.8	28.9	70.7	
7	L.A. plus E-548 oil at 0.8% in 1; L.A. in C - 2-3-4-5-6-7-8.	12.6	16.0	30.6	67.5	95.4
1	L.A. 2-100 in all sprays	12.4	15.8	36.6	64.5	
8	L.A. plus E-548 oil at 0.8% in 1; at 0.2% in 2-3; L.A. in C-4-5-6-7-8.	16.0	20.0	38.1	61.7	95.5
1	L. A. 2-100 in all sprays	20.1	26.9	56.0	50.5	
9	L.A. plus E-548 oil at 0.8% in 1-2-3; L.A. in C-4-5-6-7-8.	16.6	22.0	45.2	56.2	111.3
1	L.A. 2-100 in all sprays	31.7	42.0	89.4	34.9	
10	Zinc arsenite 3 lbs.-100 plus zinc sulfate 1 lb.& hydrated lime 2 lbs. in all sprays	29.0	41.6	71.0	40.5	116.0
1	L.A. 2-100 in all sprays	18.3	23.6	50.1	53.4	
11	Calcium arsenate at 3 lbs -100 in all sprays	23.6	33.5	48.5	50.3	94.2
1	L.A. 2-100 in all sprays	14.0	17.3	34.3	63.7	
12	Calcium arsenate 3 lbs. plus hydrated lime 3 lbs. -100 in all sprays.	11.5	14.1	21.4	74.8	117.4

(Codling moth spraying experiments, Fruitland, Idaho, 1934 Cont'd.)

Plot No.	Treatment	% Wormy Apples	No. of Worms per 100 Apples	No. of Stings per 100 Apples	% Apples Free From Injury	Rating of Plot*
1	L.A. 2-100 in all sprays	10.2	12.4	25.9	72.3	
13	Calcium arsenate 3 lbs. plus zinc sulfate at 1 lb. plus hydrated lime at 2 lbs.-100 in all sprays.	10.2	12.1	[illegible]	[illegible]	106.8
1	L.A. 2-100 in all sprays	8.4	10.3	22.1	75.9	
14	Calcium arsenate at 3 lbs. plus aluminum sulfate 1 lb. plus hydrated lime 2 lbs.-100 in all sprays.	10.1	12.5	17.1	78.9	103.9
1	L.A. 2-100 in all sprays	7.3	8.7	19.9	78.1	
15	Calcium arsenate at 3-100 plus #6 oil at 0.8% in 1-2 and 2nd brood peak; CA in C and other covers	3.8	4.8	13.7	84.8	108.6
1	L.A. 2-100 in all sprays	7.4	8.6	17.6	79.5	
16	Kalo at 3-100 plus E-548 oil at 0.8% in 1-2 and second brood peak; Kalo alone in C and other covers	5.1	5.2	13.5	83.2	104.7
1	L.A. 2-100 in all sprays	8.4	10.0	19.9	77.5	
17	Kalo at 3-100 plus E-548 oil at 0.8% in 1-2 and 2nd brood peak; Kalo alone in C; Kalo plus oil at 0.2% in other covers	4.6	5.2	13.9	84.3	108.7
1	L.A. 2-100 in all sprays	10.2	12.1	24.3	72.7	
18	L.A. plus #5 oil (dormant) at 0.8% in 1-2; LA in C-3-4-5-6-7-8.	8.1	9.6	17.3	79.5	109.4
1	L.A. 2-100 in all sprays					
19	Kalo at 3-100 plus E-548 at 0.2% in all covers; Kalo alone in C.	13.6	16.2	31.8	65.1	
		8.5	9.7	22.7	73.1	112.3
1	L.A. 2-100 in all sprays	14.9	18.1	36.7	61.3	
20	Kalo at 3-100 straight in all sprays.	18.3	21.8	43.9	52.0	86.3**

* Rating was done by comparison of percent apples free from injury and was calculated by allotting to the average of the two adjacent checks (plot 1) the value of 100.

** This plot was adjacent to but one check plot so rating could be done by comparison with but a single plot. Since plot 20 was at the edge of the orchard where codling moth injury is always more severe, the rating of the plot can hardly be considered as comparable with the other ratings.

Experiments in spray residue removal gave the following information:

"Sodium silicate is not as efficient as hydrochloric acid on most of these sprays for arsenic, lead and fluorine removal.

The fluorine is difficult to remove in all sprays used.

Appreciable quantities of both lead and arsenic were found in plots where none was applied. Lead arsenate sprayed trees were adjacent to all these plots."

- - - - -

ILLINOIS
W. P. Flint, Illinois Agricultural Experiment Station, Urbana.

Seasonal Conditions

There was a large carryover of worms from 1933. Winter mortality was low and the first brood moths emerged under favorable conditions for egg laying. First-brood worms were very abundant. The extremely hot weather and other unfavorable conditions which developed at about the start of the second brood made this brood of less importance than had been the case during the past three years.

Survey of Growers' Orchards

A survey of 120 orchards in the State made during the latter part of September and October showed a decrease in average worminess of all orchards surveyed from 15.7 percent in the fall of 1933 to 11.4 percent in the fall of 1934. There was a marked decrease in the number of worms going into hibernation and it is probable that the worm population in the orchards at the start of the winter was only about 60 to 75 percent of that in the same orchard in the fall of 1933.

The survey of growers' orchards showed lead, lime and summer oil to have given an average for the orchards surveyed of 6.4 percent entrances; lead, lime and miscible oil 11 percent entrances; lead arsenate, lime, without oil, 21.2 percent entrances. As these figures were taken from growers orchards, they should not be given the same standing as the results of experimental work because of the many other variations in the growers' spray schedule. The usual fungicides were used in all of the above combinations.

On the whole, in growers' orchards satisfactory control of codling moth was obtained where lead arsenate, summer oil and lime or lead arsenate, summer oil and spreader combinations were used. Satisfactory control was also obtained in many orchards where lead arsenate, lime and certain misicible oil combinations were used.

Results of Experimental Work

The experimental work of the season was largely confined to three lines:

(1) Tests of lead arsenate with summer and miscible oils.
(2) Tests of non-arsenical sprays.
(3) Tests of nicotine sprays.

In the experimental work at Urbana where lead arsenate, hydrated lime and the usual fungicides were used with various oils, the following results were obtained:

Table I

LEAD ARSENATE-OIL MIXTURES FOR CODLING MOTH CONTROL
Commercial Orchard
Urbana, Illinois
1934

Jonathan* and Ben Davis Picked Fruit.

Item No.	SPRAYS APPLIED				No. Apples	Percentage of Apples	
	First Brood	Amt. per 100 gal.	Second Brood	Amt. per 100 gal.		Stung	Entered
1	Lead arsenate Hydrated lime Soybean oil	3 lbs. 6 " 3 qts.	Same	-	2,000	41.0	1.7
2	Lead arsenate Hydrated lime Summer oil (Verdol)	3 lbs. 6 " 4 qts.	Same	-	1,000	47.0	7.5
3	Lead arsenate Hydrated lime Miscible oil (Dendrol)	3 lbs. 6 " 3 qts.	Same	-	2,000	55.0	11.7
4	Lead arsenate Hydrated lime Homemade Casein emulsion (straw oil)	3 lbs. 6 " 4 qts.	Same	-	2,000	55.0	14.7

* The 1,000 Jonathan apples in Items 3, 4 and 5 had 2.7, 2.6 and 5.2 percent cracked fruit respectively. This cracking was severe enough to allow washing fluid to enter. Jonathan fruit picked Sept. 20; Ben Davis fruit picked Oct. 9.

In southern Illinois lead arsenate, spreader and summer oil gave 1.3 percent entrances and 56.0 percent stings. Lead arsenate, hydrated lime and summer oil gave 7.7 percent entrances and 84 percent stings. Lead arsenate, hydrated lime and miscible oil gave 8.2 percent entrances, 86 percent stings. Lead arsenate and hydrated lime without oil gave 9.4 percent entrances and 87 percent stings.

<u>(2) Tests of non-arsenical sprays.</u>

Of the non-arsenicals, Kutane used alone at the rate of 4 pounds to 100 gallons throughout the season gave excellent control of worms but caused some premature ripening of fruit and foliage.

Natural cryolite 4 pounds, summer oil 3 quarts in all sprays except the calyx and first follow-up on Jonathan in southern Illinois gave 6.1 percent entrances, 6.4 percent stings. Lead arsenate, hydrated lime and summer oil gave 10 percent entrances and 13.6 percent stings. Natural cryolite 4 pounds, summer oil 1 quart, gave 10.6 percent entrances and 5.8 percent stings. Natural cryolite alone without oil at 4 pounds gave 33.2 percent entrances, 15 percent stings.

Comparison of Zinc and Lead Arsenates.

Zinc arsenate compared with lead arsenate showed a slight advantage for the zinc arsenate. This was put on a large block in a commercial orchard and was applied by the owner of the orchard. The fruit in this orchard was Stayman and was very badly cracked, complicating the results.

(3) Tests of nicotine sprays.

Nicotine sulfate (40%) 1-800 plus summer oil 1 percent used in peak sprays and in all second brood sprays gave 4.6 percent entrances, 1.3 percent stings. Lead arsenate, hydrated lime and miscible oil in the same schedule gave 4.1 percent entrances, 2.6 percent stings.

A new nicotine compound, 155, used at 5 pounds to 100 gallons with summer oil 1 percent gave 17.8 percent entrances, 4.3 percent stings.

Codling Moth Banding

Tests with codling moth bands were carried on to try and measure the benefit obtained from banding a part of the orchard. In this test an orchard of 30 acres had 10 acres banded and 20 left unbanded. The section of the orchard banded showed 17.2 percent entrances, 68.5 percent stings. The section of the orchard unbanded showed 29.7 percent entrances and 69.5 percent stings. As this was the first year this orchard had been banded, it is expected that the effect would show more clearly the second season. It is planned to carry on this work for at least three years.

INDIANA

J. J. Davis and G. E. Marshall, Indiana Agricultural Experiment Station, Lafayette.

The codling moth wintered in large numbers and appeared in the spring in greater numbers than in 1933. The hot, dry season somewhat checked their activities but in spite of this the pest has held its own in most regions. Codling moth investigations were conducted by G. E. Marshall:

A. The attached table gives the results of plot tests with insecticides. There is no question regarding the value of oil with stomach poisons to increase adhesiveness and reduce stings, although with the use of oil the removal of residue becomes increasingly difficult.

B. (1) Bands. Results not yet available.

(2) The packing house of Troth - Burton was screened as it has been for several years. This house is 72 x 72 and three stories in height. This year electrocutor light traps were installed. A total of 235,000 moths were accounted for by August 1 and when the screening was removed just before apple harvest a careful estimate of the moths which died between the building and cloth screen revealed 30,000 not previously accounted for, making a grand total of 265 000 moths which were prevented from escaping to the orchard at a cost of $23.

(3) No work was done with bait traps as a control measure.

(4) Several sets of experiments were conducted, in cooperation with T. E. Hienton of the Agricultural Engineering Department, with a variety of lamps in a fundamental study of the relative attractiveness of different light rays and different light intensities. The complete tabulations are not yet available.

(5) Parasite Control. Nothing has been done along this line.

SUMMARY OF SPRAY PLOT RESULTS - TROTH-BURTON ORCHARD, 1934

Plot and Treatment	U. S. No. 1's Per 100	Worms Per 100	Stings Per 100	Clean Fruits Per 100	No. Apps. Per Bu.	Injury by Treatment
1. Lead arsenate 3# and lime 6# in all sprays.	8.32	27.11	609.2	4.36	210	None
2. Lead 4#, lime 4#, Verdol 3/8% first brood; 1½% Verdol and oleic acid remaining sprays.	3.44	33.7	239.5	20.1	252	Fruit dropped early.
3. Lead 4#, lime 4#, Dendrol ½% (¾% at peaks. Bordeaux used in two first brood sprays.	24.8	10.9	338.5	12.4	236	Tendency to russet. Lentical eruptions noticeable.
4. Lead 4#, Ortho Dry Spreader 1#, with ½% Ortho K at peaks.	34.3	5.4	275.8	16.6	180	Best finish of any. Some fruits with rough surface. Residue in pellets.
5. Dutox 4#, Verdol ¾% (½% in second brood sprays)	64.1	24.4	70.2	45.8	358	Severe oil spotting and cracking on Grimes. Small size.
6. Lead 3#, lime 3#, Knight oil #2436 - ¾%, with varying amounts of oil (½% to 1% in different applications	83.2	3.8	45.2	68.0	292	Badly oil spotted. 4% Winesaps cracked. Grimes small.

SUMMARY OF SPRAY PLOT RESULTS - TROTH-BURTON ORCHARD, 1934 (Continued)

Plot and Treatment	U. S. No. 1's Per 100	Worms Per 100	Stings Per 100	Clean Fruits Per 100	No. Apps. Per Bu.	Injury by Treatment
7. Natural Cryolite (Kalo) 4#, Ortho K ½% with ¾% at peaks.	87.2	4.9	36.9	61.5	275	Foliage on Winesap very poor at harvest.
10. Lead 4#, Grandpa' soap ½#, Ortho K ½% (¾% at peaks).	82.9	1.16	57.7	62.5	253	Shallow cracks numerous.
11. Cuprus cyanide (Kutane) 3#, Ortho K ¾% (1% at peaks).	39.8	26.3	186.7	22.3	239	Moderate oil spotting on Grimes and some cracking. Winesaps with poor color.
12. Synthetic Cryolite 4#, Ortho K ¼% (½% at peaks).	36.1	45.9	118.5	21.2	312	Cracking severe, resulting in brown rot.
13. Zinc arsenate 4#, Dendrol ½% (¾% at peaks) After June 20 Ortho K replaced Dendrol.	26.4	20.8	354.2	20.5	254	Slight cracking and lentical eruptions.

(6) Inasmuch as the major orchard infestation may often originate from larvae overwintering in debris on the orchard floor surface, a study was begun to determine the value of burning the floor surface. Two burners, originally developed for corn borer control, were loaned by Messrs. R. M. Merrill and O. K. Hedden of the Bureau of Agricultural Engineering, U. S. Department of Agriculture.

A block of Grimes and Duchess, 28 by 18 trees, was used in the experiment. The Grimes bore a heavy crop in 1933 and very few apples in 1934. The Duchess bore no fruit in 1933 and a full crop in 1934. The burning was done in March and April of 1934. In one area the entire ground surface was burned over and in another area only the surface beneath the trees was burned. A check plot was included where no burning was done. The entire block received the same spray treatment.

The Duchess variety was used to determine the efficiency of the treatment, and the following results obtained:

Treatment	Average number of entrances and stings per 100 apples
Check - No burning	98.45
Burning beneath tree only	81.00
Burning entire ground surface (between rows and beneath trees)	81.80

One man can cover 22 to 25 trees a day at a cost of 25 cents per tree, if only the area beneath the spread of branches is burned and the burning done during the winter months. If burning is done in late spring, when the debris beneath the tree must be raked out in order to prevent injury to the tree by the large amount of inflammable material, then the cost is about 57 cents per tree. Injury is less likely to result to the tree if the burning is done in cold weather.

(7) For several years Marshall has been attempting to develop a material which can be used in cavities, split branches and the like, which are favorite places for cocooning and which are inaccessible to birds and not reached by present treatments. The material which has given best results is prepared by heating together one part of alpha naphthalamine and two parts parawax. While the ingredients are being heated add hydrated lime till the mixture is the consistency of a very thick batter. This material remains effective for three or more years. Care should be taken to avoid applying to large areas of live wood.

III. Residue and its Removal.

A. Experimental Work.

(1) Removal of lead and arsenic.

Tests in the removal of lead and arsenic residues by washing in an underbrush machine and in the most recent type of flotation washer with an underbrush pre-dip tank have been very extensive at this station this fall. The temperatures in these tests ranged from 50 to 60 degrees to 110. Such temperatures were tested both in the pre-dip tank and in the washers. Many strengths and combinations of washing materials were used in the solution including Vatsol, Hydrochloric acid, and B. W. Sodium silicate. A newly developed wetting agent produced by the General Chemical Co. was also tested.

Removal of fluorine compounds

Many of the same compounds were used in tests to remove three types of fluorine sprays.

Prof. C. L. Burkholder has carried on extensive tests in the removal of heavy loads of lead and arsenic and I am therefore asking him to give you the results of his experiments.

B. Growers Experiences.

Approximately 30 percent of the acreage of commercial apple orchards of Indiana is equipped for washing. Old flood type washers are by far the most numerous, with a few of the later under-brush type machines in use and to our present knowledge only one of the latest flotation type washer. Many of these machines are following a pre-dip of the flotation or under-brush type.

Since 1934 has been an exceptionally hazardous year for many fruit growers from the standpoint of codling moth control, and since lead arsenate has been used very extensively and in large quantities and oftentimes with an oil sticker, the results in residue removal have varied greatly. With a few of the heavier spray programs, residue removal to below the Federal tolerances has been almost impossible. Concientious growers who have used high acid concentrations, high temperatures, and various wetting agents to facilitate residue removal have in some cases damaged fruits of some varieties. There is no question but that growers are in most cases making a strenous effort to comply with Federal tolerance regulations.

IV. We have not yet formulated recommendations for 1934. Supplementary controls undoubtedly will have an important place in our recommendations.

IOWA

C. H. Richardson and T. R. Hansberry, Iowa Agricultural Experiment Station, Ames.

Codling moth infestations have been of about moderate dimensions over most of the State, varying in well-sprayed apple orchards from 30 to less than 1 percent of wormy fruit in the southern and southwestern sections to about 30 to 40 percent in the central part of the State. Bait trap records showed little or no second and third brood moths in southern Iowa and an average first and second brood and a full third brood in the west and central portions. In an orchard at Lineville where daily maximum temperatures of 110° F. prevailed for weeks in July and August and a maximum of 118° was reached, few moths were caught after June 10, and at harvest, the crop was practically free of worms.

<u>Insecticide experiments</u>. Two orchards, one at Mitchellville, the other at Des Moines, were selected for the insecticide experiments. At Mitchellville, plots, of 6 trees each, were randomized in a 4 by 4 latin-square arrangement; at Des Moines the plots, also of 6 trees each, were arranged in duplicate so that one plot receiving each treatment fell on the outside and one on the inside of the experimental block. The variety in each locality was Ben Davis. Just before harvest, 3 trees within each plot were selected for uniformity of size of tree and yield of apples; and at harvest the entire crop of each

tree so chosen was scored separately in successive lots of 10 apples for the number of wormy apples. This experimental design therefore furnished data from 12 trees for each spray schedule at Mitchellville and from 6 trees for each schedule at Des Moines. Windfall apples were disregarded in this study. The results follow.

Schedule	Treatment	Location of Orchard	Av. percentage of wormy fruit	Residue at harvest grain per lb.	
				Pb	As_2O_3
A	Lead arsenate, 3# to 100 gals. plus lime, 6# to 100 gals. 6 sprays (calyx & 5 covers)	Mitchell-ville	52.5	.018	.015
	" " "	Des Moines	30.1	.016	.012
B	Calcium arsenate: Calyx spray lead arsenate, 3# to 100 gals. plus lime 6 lbs; 5 cover sprays calcium arsenate 3# to 100 gals. plus safener ($FeSO_4$ 1 lb. to 100 gals. and lime 2 lbs. to 100 gals.)	Mitchell-ville	42.0	-	.012
	" " "	Des Moines	22.5	-	.008
C	Manganese arsenate: Calyx spray lead arsenate, 3# to 100 plus lime 6#; 5 cover sprays Mn arsenate 3# to 100 plus fish oil 1 qt. to 100	Mitchell-ville	48.0	-	.022
	" " "	Des Moines	27.3	-	.009
D	Lead arsenate-oil nicotine, Calyx and 3 cover sprays, Lead arsenate 3# to 100 gals. + 6# lime; 2 cover sprays summer oil 1% plus nicotine sulphate 1 pint to 100 gallons.	Mitchell-	28.8	.019	.008
	" " "	Des Moines	16.7	.014	.007

Note: The fungicide used in the calyx spray of all schedules was lime-sulfur, 2.5 quarts in 100 gals. No fungicide was used in the first cover sprays. All cover sprays thereafter contained Bordeaux mixture 1-3-50.

Comment on the results. The figures for wormy fruit represent percentages based upon total fruit receiving each treatment. They have not yet been tested statistically for significance but it is apparent that no important differences in effectiveness exist between the lead arsenate, calcium arsenate and manganese arsenate treatments either at Mitchellville or at Des Moines. Evidently the level of codling moth infestation was higher at Mitchellville than at Des Moines, for there is a spread of approximately 20 points between the means for the arsenical plots in the respective orchards. It is worthy of note, however, that the relative differences are about the same in the two orchards. The arsenical residue on the fruit at harvest was satisfactory except on that from the manganese arsenate plots at Mitchellville. This may be the result of sampling error, of inequalities in the number of gallons of spray material applied per tree in the two orchards, or to other causes. The lead residue on the fruit from the two orchards treated according to schedule A are concordant and within the tolerance.

The lead arsenate-oil-nicotine treatment gave apparently greater effectiveness than the other treatments in both orchards. Again the level of infestation appeared to be lower in the Des Moines plots, but the relative difference was approximately the same as that between the arsenical plots. Residues for both lead and arsenic were concordant and satisfactory.

Foliage injury: No foliage injury, attributable to any particular spray application, was observed in these experiments. Spray injury from lime-sulfur was observed in many parts of the State, and injury even from lead arsenate and lime was often reported. Apparently any liquid application produced some injury during this hot, dry season. It is interesting to note that under the unusual weather conditions calcium arsenate and manganese arsenate produced no more injury than lead arsenate.

Codling moth infestation in apples of the "June drop". An examination of fallen apples made during the period from June 15 to 25 in 13 localities in Iowa showed that about 38 percent (average) of the fruit was damaged by the codling moth and that at the time it was gathered about 86 percent of the worms had left the apples. Evidently, during the past season, most of the larvae had left the fruit before it fell from the tree.

Banding experiments. Old apple trees were singly banded on the trunk and doubly banded (on the trunk and on the larger limbs above the areas of rough bark) to determine (1) whether double banding was more effective than single banding and (2) whether more larvae descended from the upper part of the tree than came up the trunk. The results were: (1) The bands on the doubly banded trees had captured by harvest time an average of about one-third more larvae than those on the singly banded trees; (2) more worms by an average of about one-half came down from the upper parts of the tree than ascended from the trunk.

KENTUCKY

W. A. Price, Kentucky Agricultural Experiment Station, Lexington.

I. Codling moth increased generally this year. This increase came early in large orchards and in some instances decreased towards end of the year. Increase in small orchards was very noticeable later in season.

Some eggs went into harvest sheds and entrances occurred following common storage.

II. A Lead arsenate was used exclusively and with satisfactory results. No substitutes were used.

L. P. Menhadden fish oil was used in centers with heavy infestation as an adhesive. Where used throughout the season, residue was reported to be above tolerance.

III. In laboratory tests pine tar oil, saponfied or with soap, acted as a mild buffer for soluble arsenic in preventing plant injury where soluble arsenic occurs in small quantities.

Birds were very active in destroying codling moth overwintering in trees. One grower reports 98% on unpoisoned bands.

Bands made with beta naphthol in oil have replaced 99% of all hand operating bands. In all probability there will be an increased use of bands in 1935.

Our growers are equipped to wash about 50% of the commercial acreage. Flood and dipping types of machines are used with fair success.

IV. We plan to recommend the use of lead arsenate in Kentucky during the coming season (1935).

MARYLAND

H. S. McConnell, Maryland Agricultural Experiment Station, College Park.

The codling moth situation in Maryland showed considerable improvement in 1934 over previous years. The most marked improvement was on the Eastern Shore where the codling moth infestation had been the heaviest for a number of years. There was no marked change in the western part of the State. While the State as a whole showed some improvement this year there are still many orchards in which the codling moth is doing serious damage.

The improvement noted can be attributed to a number of factors, the most important of which are: More thorough spraying, increased use of arsenate of lead, supplementary control measures, as scraping and banding, and some increase in washing machinery which permits more thorough spraying and the

increased use of arsenate of lead.

Some tests were conducted to determine the relative efficiency of arsenate of lead and several brands of calcium arsenate. In general the arsenate of lead was superior to all brands of calcium arsenate. There was little to choose between several brands of calcium arsenate. There were differences in injured fruit counts, but apparently not greater than is expected in a series of plots.

Natural cryolite with and without oil was used on some plots early in August and apparently reduced the damage some. It was more effective where oil is used as a sticker.

Some counts were made on fruit sprayed by the Maryland Horticultural Department in which a straight arsenate of lead schedule was applied to some trees, arsenate of lead plus fish to some, and arsenate of lead plus mineral oil emulsion to others. All of these plots showed a low codling moth infestation.

Hail destroyed the experimental work in western Maryland.

- - - - -

MASSACHUSETTS

A. I. Bourne and S. D. Edmond, Massachusetts Agricultural Experiment Station, Amherst.

Early this summer the New England Rural Electrification Committee, co-operating with the Western Massachusetts Counties Electric Light & Power Company, and the Massachusetts State Experiment Station started a light trap experiment at the Bay Road Fruit Farm in South Amherst, Mass., which had a fine record of orchard management and fine bearing trees.

Installation of Equipment. Five bulb and pan and five electrocutor traps were installed in parallel rows. Electric power was supplied from wires running from a take-off from the main power line at the edge of the orchard. Two poles were used for this purpose, one at edge of the orchard and another five trees in from the edge. On the outer pole was placed an automatic time clock, fuse-box, and cut-out switch, and on the pole in the orchard was placed a recording thermograph.

Types of Light Traps. The electrocutor traps consisted of a 75-watt bulb suspended inside of a screen charged with about 1100 volts from a transformer in the top of the trap. Beneath the circular screen was suspended a wire basket to catch the insects which were electrocuted while flying through the charged screen toward the light. The bulb and pan traps consisted merely of a 75-watt bulb suspended over a pan of water, the surface of the water acting as a reflector to which the insects were attracted and drowned.

Operation of the Traps. The lights were operated each night except rainy ones from June 18 until August 28, under control of an automatic time clock in series with the power line to the traps. The lights were on from

one-half hour before sunset until about one-half hour before sunrise, corresponding to the flight period of the insects present in the orchard. Lights were turned off on rainy nights when insect flight was very slight. Each day the insect catch of the night before was counted and identified.

Number of Insects Caught. From the traps a large number of insects was obtained. A total of 42,857 insects were counted and identified, of which 1,498 were beneficial species. Thirteen orders were captured of which the order Diptera, the flies, presented the greatest number of families with 25, with the order Lepidoptera, the moths, following with 17. Orchard pests were counted as follows: Codling Moth 321, Apple Tent Caterpillar 684, Forest Tent Caterpillar 52, Bud Moth 43, Cherry Leaf Roller 35, Plum Curculio 1, and Apple Maggot 1.

Efficiency of the Traps. These numbers are only indicative of the actual numbers caught in the traps as the electrocutor traps completely burned an average of 93% of the insects entering them as determined by counts of the "Clicks" made by insects which caused an arc in the current while flying through the charged screen. Even with this low efficiency the electrocutor traps were 3.7 times more effective than the bulb and pan traps in numbers of insects caught; the latter type traps, however, secured a greater variety of insects though in smaller numbers.

Season Emergence of Codling Moth. The primary purpose of the experiment was to determine the relative numbers of codling moth, the time of emergence, and the possible control of the pest by means of the light traps. Seasonal catches of this insect as indicated by the chart shows that the stragglers from the first brood were present in the orchard until July 14. The second brood appeared a few days later and reached a peak of moth emergence on August 10, then receded slowly to the last night the light traps were operated on August 28. A comparison of these figures with emergence cage figures in 1924--Massachusetts Experiment Station Bulletin No. 233--shows that emergence from the cages was a few days slower in the cages than was actually the case in the orchard as indicated by the light traps, making allowance for any differences in seasonal emergence in the two years in which the records were taken. This seems to indicate that the light traps are perhaps more valuable than the emergence cages in determining the correct timing of orchard sprays than in the actual control of the codling moth by this method.

Temperatures and Codling Moth Flight. Temperature had a direct influence on codling moth flight, high temperature during the period in which the lights were operated producing an increase in moth flight, whereas low temperatures produced the opposite result. Precipitation caused a decrease in flight even when favorable high temperatures prevailed, indicating that rainfall was sometimes the limiting factor in moth flight.

Records of Fruit Injury Counts. Counts of all kinds of insect injury on McIntosh apples in the orchard gave the following results: The row of electrocutor traps had 93.1% clean fruit, while the bulb and pan row had 92.5% clean fruit. On unlighted row adjoining the first named row was 95.0% clean, whereas the third row adjoining contained 86.1% clean fruit.

Codling Moth Injury Counts. Codling moth injury in the row trapped by the electrocutor traps was .4%, and in the row trapped by the bulb and pan traps, 1.35%. In one row adjoining the first-named traps injury was 2.9%, and in the third row adjoining, 7.5%.

Codling Moth Band Records. Band catches of codling moth larvae furnished a definite indication of the value of the light trapping. Twenty-one larvae were caught in the bands in the electrocutor trapped row, whereas 19 were caught in the bulb and pan trapped row. A ring of 12 trees in a circle one row outside of the two light rows contained 160 larvae, while the circle formed by 22 trees in the third row outside the lighted rows contained 537 larvae. In the 44 banded trees 737 larvae were present, even after the regular spray and dust schedule.

As an aid in the supplementary control of orchard pests when combined with the regular spray program, as a means of timing the spray schedule according to the emergence of the different orchard pests, and as a means of securing a record of the occurrence of the various insects both harmful and beneficial, insect light traps seem to have a value to the commercial fruit grower.

- - - - -

MICHIGAN

Ray Hutson, Michigan Agricultural Experiment Station, East Lansing.

I. Seasonal conditions and codling moth abundance during the 1934 season:

During the season of 1934 the weather was so extremely dry in the locality where our experiments were conducted that the size of fruit was very adversely affected. The high summer temperatures following unprecendentedly low winter temperatures, together with the effect of lack of rainfall on amount of arsenic per unit area of fruit and the cumulative effect of supplementary control measures resulted in less damage from codling moth than for several years past.

II. Results of experimental work:

A. Control by insecticides:

Our plots were randomized and results in each case represent the average of two or more plots of nine trees each for every treatment.

1. Lead arsenate plots receiving a calyx and five cover sprays gave the best control, averaging 95% of uninjured fruit on Dutchess, Wagner, Wealthy, Jonathan, and Peerless. This is in accord with the results of other years. Little or no burning occurred in our lead arsenate plots. Arsenic and lead residues on lead plots were above the tolerance.

2. (a) Zinc arsenate for the second consecutive year proved almost as efficient as lead arsenate. Arsenic was above the tolerance; lead far below. No burning.

(b) Calcium arsenate showed considerable promise when substituted for the calyx and 10-day spray in the lead schedule in an effort to reduce residue.

3. No fluorine compounds tested.

4. Cuprous cyanide gave excellent control without the burning noted by several other workers.

5. (a) Summer oil emulsion 3 quarts plus nicotine sulphate $\frac{3}{4}$ pint applied at weekly intervals gave almost as good control as lead arsenate. Our highest control consisted of calyx and 10-day spray of lead arsenate 3 pounds with lead arsenate 3 pounds and oil 3 quarts at the peak of the first brood, followed by 7 oil-nicotine sprays as above at weekly intervals.

(b) Nicotine tannate plus bentonite sulphur controlled codling moth while it was used, but was abandoned in midseason because of severe burning on fruit and foliage.

(c) No derris.

(d) No pyrethrum.

(e) No other straight organics, although nicotine-bentonite (Black Leaf 155) gave good control.

B. Control by means other than spraying:

1. Chemically treated bands were used extensively in experimentation and by growers. Orchards which have been banded for two or more years show improvement in control without perceptible change in spraying materials or method beyond that in similarly sprayed but unbanded orchards.

2. Attention to storage house sanitation resulted in the capture of 21,000 codling moth adults which would have escaped into an 8-acre plot beside the building as a delayed first brood. A pan of kerosene below a forty watt light bulb in the tightly closed storage was sufficient to collect these moths.

3. Bait traps were employed as an adjunct in timing sprays. Our experience again this year indicates the necessity of checking them against other methods under our conditions. Observations upon untreated bands in the orchard have shown moths emerged days before bait traps began to record their activity.

4. An installation of 30 light traps showed no advantage over unlighted areas in the same orchard.

5. No work on parasitic control.

III. Residue and its removal:

A. 1. The residue removal work has been under the immediate supervision of W. C. Dutton of the Horticultural Department. He has reported the possibility of removing any lead or arsenic residues ordinarily used in Michigan by simple modification of the acid bath.

B. Growers' experiences with residue removal:

1. Only a small proportion of the acreage is yet equipped for washing, although the amount of washing this year is probably 2 to 3 times what it was last year.

2. Most washing is carried on with modern commercial washers, although some homemade flotation washers have been satisfactory.

3. Only a few have had trouble in removing residue and those few because of an excessive number of lead arsenate-oil sprays.

IV. Recommendations proposed for the 1935 crop season:

Scrape and band, lead arsenate 3 lbs. plus 4 lbs. lime with or without fungicide calyx and at least 5 other sprays and wash. To avoid washing oil-nicotine at weekly intervals after no more than 2 lead arsenate sprays.

- - - - -

MISSOURI

L. Haseman, Missouri Agricultural Experiment Station, Columbia.

I. Season Conditions and Moth Abundance.

The 1933-34 winter in Missouri had two short, sharp subzero periods but we had a high survival of hibernating larvae. The early part of the season was quite normal and the first-brood sprays went on in good shape. With few exceptions, the best control in years was secured on first-brood worms and only a few commercial orchards which had very heavy carryover had difficulty. Peaks of first-brood (spring-brood) moths occurred at about the normal time, May 12-19 in south and central Missouri and May 19-26 in north Missouri. The moths came out with a rush this year. When the drought and heat struck in July and early August most breeding practically stopped so that second-brood worms were not a serious problem at all in most orchards. Even in the laboratory we lost out on eggs and second-brood worms. Unbelievably large numbers of second-brood moths were trapped in bait jars but they laid few eggs and few of these hatched. At that time it looked as though the fight was over. Second and third-brood moths emerged a little ahead of 1933 and were quite scattered. The rains came and temperatures moderated so that third-brood moths reproduced quite normally and many growers had serious trouble with late worms though, generally speaking, this year's control has been the best in several years.

II. Results of Experimental Work.

A. Control by Insecticides.

In our experimental work this year we placed special stress on the timing of the sprays and on a study of the part oil emulsion plays when combined with arsenate of lead.

Our arsenate of lead plats this year, in the same orchards used in 1933, showed much better control of both worms and stings. However, the small number of second-brood worms, due to weather conditions, helped out. Records taken at picking time showed that from 60 to 80 percent of worminess was due to late worms which developed after the heat and drought was over.

Of the non-lead arsenicals, we have been testing especially zinc arsenate and this year's results compare very favorably with the arsenate of lead plats. Arsenate of lead in the peak sprays with arsenate of zinc in the other sprays gave especially good results. Also arsenate of lead combined with Paris green is being used safely and seemingly with good results by some of our growers, but we did not use this combination in our experiments this year.

In a cooperative experiment with the Crop Protection Institute, three non-lead materials were used and, while I have not been advised as to what the materials were, I have been able from the results to readily pick out presumably the lead plats.

Fluorine compounds were used in only one of our experimental orchards and presumably under ideal conditions, but it did not compare favorably with arsenate of lead.

Cuprous cyanide (Kutane) was used in one plat and worm control was quite satisfactory, but serious damage to foliage and fruit resulted.

Oil-nicotine and nicotine bentonite did not give us as good control as lead arsenate.

We did not include derris, pyrethrum and nicotine tannate as they were being given careful attention in the Federal experiments at DeKalb, Missouri.

In contrast with our past experience, oil emulsion added to arsenate of lead in the peak sprays this year gave marked improvement in control. However, we attribute this, in part at least, to the season, for our previous results have shown that while the addition of oil reduced stings it did not reduce entrances.

B. Control by Means Other Than Spraying.

In our banding work this year we secured very satisfactory results, except for one new commercial brand of band. This band tended to lose its beta naphthol after being on the trees for a time and allowed considerable pupation and the emergence of too many moths. Both cold-dipped and hot-dipped bands gave us good results. Except for a few growers who had trouble early

with the above poor commercial bands, Missouri growers practically all went to chemically treated bands this year.

A number of our growers cooperated in testing out the value of storing used equipment in their packing houses and in mothproofing the houses. In one where the mothproofing was not completed until moths began to fly traps set in the walls of the house caught about 12,000 moths. In a second house better than 60,000 moths were trapped. In the Marionville area, where we have been carrying on part of our experimental work, growers cooperate in storing all used boxes in the storage plant and then fumigate by burning sulphur, which has been quite effective in killing the larvae and it also takes care of storage molds.

A statewide C.W.A. orchard sanitation project was carried out during the winter and early spring, which helped in the important apple growing areas and also greatly stimulated commercial growers to do a better job of orchard cleanup work. We felt that the work was of far-reaching value.

Following up some very promising results secured in 1933 by picking wormy fruits and destroying wormy drops, many growers this year thinned and removed wormy apples systematically but less striking results were secured than in 1933.

In our bait trap work we made a study of catches in three types of containers but did not undertake any detailed study of fermenting material. We used Diamalt mostly, but to a small extent brown sugar, molasses, cider, and beer. Of the three containers, wide-mouthed fruit jars gave us a larger catch than either metal funnels or covered metal pans. In our work here we have used bait traps primarily for following the daily moth activity in each orchard where we are carrying on experiments besides in a number of other orchards where the growers run them. We would be lost in trying to keep in daily touch with the pest without bait traps.

We did not get around to light trap work this year.

In 1933 we followed the introduction of Trichogramma minutum in one Jackson County orchard, and in 1934 we again made some observations on it. In 1933 large numbers of eggs were parasitized, but in spite of a rather heavy spray schedule the worms practically took the crop. In 1934 there appeared to be no marked carryover of the parasite.

This fall in central and in southwest Missouri, while collecting our supply of hibernating worms, we have found a rather marked abundance of larval parasitism, perhaps 1 to 2 percent. It is seemingly Ascogaster carpocapsae (Vier.).

III. Residue and Its Removal

A. Results of Experiments With Residue Removal.

We have left the study of residue removal largely to our Department of Horticulture. In 1933 they carried on an extensive study to try and determine the amounts of residue on fruit at picking time where different types

of spray schedules were used. Their results indicated that with normal rainfall our heavier lead schedules could be properly taken care of by the acid bath, while in most cases lighter lead schedules could be handled by the brush machines of which we have a few in Missouri. This year with our heavy fall rains and a general letting down on second-brood sprays, due to scarcity of worms, our horticulturists have felt sure that washing would handle all crops in Missouri. As a consequence, they have not carried on much residue removal work.

B. Growers' Experiences With Residue Removal.

Generally speaking, with the light crop and a fall in which the fruit did not drop badly, our growers had plenty of time to pick and wash, so we have had no complaints from them as regards trouble with residue removal.

Practically every commercial grower has either one of the standard commercial washers, or one of the recommended homemade washers. In some of the larger fruit areas cooperative washing is done.

During the last few years when the Department of Horticulture arranged to test washed fruit for the growers few samples which were properly washed failed to meet the tolerance of lead and arsenic.

The fluorines have been used in Missouri only in an experimental way by our growers, so they have not had any fluorine residue problem.

IV. Recommendations Proposed for the 1935 Crop Season.

Our recommendations for 1935 will be substantially the same as for this year. While we are carrying over a much smaller worm population than a year ago, we are urging our growers to be prepared for another heavy campaign of control. We are stressing supplementary controls followed by a careful timing of a heavy arsenate of lead spray schedule where worms have been serious and with a lighter schedule where worms are less serious, with perhaps the use of lead substitutes in some sprays. We are expecting to continue our close supervision of the sanitation work and the timing of the sprays next summer.

- - - - -

NEW JERSEY

B. F. Driggers, New Jersey Agricultural Experiment Station, New Brunswick.

The New Jersey Station devoted most of the time in codling moth work in 1934 to the testing of a number of fixed nicotine compounds in comparison with the standard lead arsenate and the lead arsenate-oil sprays. Twelve different spray combinations were block tested in the field, once on the Stayman variety and once on the Winesap variety. Blocks ranged in size from 12 trees on the Winesaps to 16 trees on the Staymans.

The relative effectiveness of the different spray materials in controlling the codling moth was determined by the following methods. (1) At the end of first brood larval entry, four hundred apples were examined at random on each of three trees in each block. (2) The three "count" trees in each block were scraped and banded with burlap and the larvae collected once a week during the season. (3) Dropped fruit was picked up and scored as "stung", "wormy", and "clean" once a week from July 1st to harvest on the "count" trees. (4) All the fruit on the three "count" trees in each block was examined and scored for codling moth injury at harvest. In addition to these biological data nicotine analyses of fruit and foliage on the fixed nicotine blocks were made throughout the season.

At the end of first brood the blocks showing the best control in the order named were: (1) nicotine tannate + bentonite sulfur; (2) nicotine sulfate + bentonite sulfur + soap (tank mixed); and (3) lead arsenate + summer oil.

At harvest the block sprayed with nicotine sulfate + bentonite sulfur + soap tank mixed and the block sprayed with lead arsenate + oil showed the best control of codling moth. The tank mixed nicotine tannate and bentonite sulfur and the tank mixed nicotine tannate and bentonite gave the next best control. Those blocks sprayed with nicotine sulfate, bentonite and soap, with and without copper, in which the materials were processed before adding to the tank, gave uniformly poor control. It appeared that too much spreader was present in these materials which caused an excessive run off.

The foliage and fruit analyses for nicotine showed that those blocks which failed to stop the codling moth satisfactorily had a low nicotine charge per unit area of fruit and foliage immediately after spraying and the nicotine that was deposited practically all disappeared during the ten-day intervals between spray applications. The foliage analyses definitely showed that the tank mixed bentonite and nicotine was superior to the processed bentonite and nicotine in establishing and maintaining a charge of nicotine on the surface of the fruit and foliage.

A careful study of the foliage injury on the lead arsenate and the lead arsenate-oil blocks was made in October and a similar study at the same time was made on several of the fixed nicotine blocks. The data from the blocks were compared with similar data from a check block which had received no sprays after the calyx. The check block and the block sprayed with tank mixed nicotine sulfate-bentonite sulfur-soap showed a 30 percent leaf drop for the season. The block sprayed with tank mixed nicotine tannate-bentonite sulfur showed a 42.6 percent leaf drop, and the standard lead arsenate and the oil-lead arsenate blocks showed a leaf drop of 45 and 51 percent, respectively. Of the foliage remaining in October, no severe burn was found on the check and fixed nicotine blocks, whereas, approximately one-third of the foliage was severely burned on the standard lead arsenate and the oil-lead arsenate blocks.

- - - - -

NEW YORK

S. W. Harman, New York Agricultural Experiment Station, Geneva.

I. Compared with the previous season there was no material change in the codling moth situation in New York State during 1934. The Hudson River and Lake Champlain Valley sections were fortunate in that the problem was comparatively simple, requiring only first-brood sprays, and with no residue problem. In western New York the situation was different. From four to six cover sprays were required, and in the more severely infested areas there was more spraying with heavier dosages of poison than ever before. There was no difficulty with spray residue as the cold storage plants are well equipped with large commercial washers.

II. A (1) The standard dosage of lead arsenate (3 lbs. in 100 gallons) was inadequate to handle the more severe infestations. By increasing the dosage to from 5 to 6 pounds in 100 gallons, or by using oil in the first brood sprays in addition to the regular lead arsenate schedule, satisfactory control was effected.

Hydrated lime was used with lead arsenate to prevent possible injury to fruit and foliage.

(5) Tests with fixed nicotine compounds indicated the following results: In this connection it should be mentioned that 1934 was a comparatively dry season with only 7.71 inches of rain from the first of June thru September as compared with a normal precipitation of 11.85 inches.

1. 5 pounds of "Black Leaf 155" was about equal in value with 6 pounds of Kolofog +3/4 pint of nicotine sulfate when applied weekly for 11 applications during the summer.

2. Five pounds of Black Leaf 155, when used in all the cover sprays, was very much inferior to an equal number of applications of lead arsenate used at the rate of 3 pounds in 100 gallons.

3. Black Leaf 155 did not give effective control in heavily populated orchards unless applied every week or ten days.

4. Bentonite-nicotine sulfate and oil-nicotine sulfate sprays when used against the second-brood worms compared favorably with lead arsenate.

5. The nicotine compounds, such as oil-nicotine and bentonite-nicotine, when used following earlier applications of lead arsenate did little to relieve the residue problem. These sprays, because of their exceptional adhesive properties, sealed on the lead arsenate, so to speak, and prevented any appreciable weathering. Spray deposits containing bentonite were usually among those most difficult to remove.

B. 1. The use of chemically treated bands in the heavier populated orchards in western New York is becoming a popular practice to supplement the regular spray program.

4. Light traps.

"The light-trap investigations have steadily progressed to the point where it can be safely said that the light traps do influence the codling moth population and that the reduction in the number of moths, coupled perhaps with other light effects, is reflected by a measurable degree of immunity of the fruit from insect injury."

III. A (1) An intensive spray program using 5 to 6 pounds of lead arsenate in 100 gallons in the more severely infested areas left considerable residue on the fruit (12 times the arsenic and 15 times the lead tolerance in some instances).

Hydrochloric acid 1 1/2 percent used in commercial brush type washers effectively removed the heaviest residues from fruit at picking time.

When summer oil was used with lead arsenate it was necessary in some cases to heat the acid bath to 85° F. to effectively remove the residue. The heated solution was also required to clean fruit taken from storage. The addition of Vatsol (8 lbs. in 100 gals.) to the heated acid solution rendered the washing process more effective, but there were only a few instances where this procedure was necessary.

B. Western New York is well equipped with washers and dry cleaners. Most of the washing machines are large commercial models erected in cold storage plants.

IV. Recommendations for 1935.

Lead arsenate will probably be the general recommendation for codling moth control. In the areas of serious infestation increased amounts of lead arsenate and the oil-lead arsenate sprays will be used to some extent.

- - - - -

OHIO

C. R. Cutright, Ohio Agricultural Experiment Station, Wooster.

I. 1934 was the fourth consecutive Ohio season with deficient rainfall and excess temperatures. The initial population of codling moth was somewhat heavier than in 1933 due to successive favorable seasons and also due to the calcium arsenate spraying program of 1933 which increased the number of larvae in orchards. Due to these factors, and also a partial crop failure in many sections, codling moth injury was generally more severe in 1934 than in 1933; that is, in percentage of fruits injured. The peak of spring brood moth emergence was about a week earlier than normal and larvae appeared under bands at a much earlier date. During midsummer, the extreme heat seemed to slow up development but much late injury occurred in September.

II. A. (1) Lead arsenate did not control as well as usual unless extra sprays were applied. The plots sprayed with the scheduled number of applications (petal fall and three covers) in most instances showed an increase in infestation. This applied to all sections of the State.

(2) Non-lead arsenicals used pound for pound with lead arsenate did not give good results. When the amount of calcium arsenate or of manganese arsenate was increased 50% over that of lead arsenate, very good results were obtained in midsummer spraying.

(3) Fluorine compounds, when used with oil as a sticker, were effective, especially if the schedule called for frequent applications. The omission of the oil lowers the efficiency markedly. Natural cryolite seems to be the most effective fluorine compound.

(4) Cuprous cyanide (Kutane) was fairly effective in worm control but caused serious fruit russeting of most apple varieties. Noticeable defoliation occurred on Stark and Mammoth Black Twig.

(5) (a) Oil-nicotine gave a good account of itself in 1934. It was especially effective where a schedule calling for numerous applications was applied.

(b) Nicotine-tannate with bentonite-sulfur was used in one test, two applications against one of lead arsenate being tried. The results were approximately equal.

(c) The commercial nicotine preparations Black Leaf 155 and 155Bx were tested both with and without a special soap spreader. Compared with an equal number of lead arsenate applications, they were ineffective.

(d) No Derris or Pyrethrum extracts were tested.

B. (1) (a) Great numbers of larvae are captured and killed under the Standard Beta-naphthol bands. This, rather than any proven reduction in the amount of infested fruit, accounts for their continued use and recommendation.

(b) Untreated bands were used only as a means of collecting larvae for biological work.

(2) Sanitary measures are recommended and generally employed in the State but no definite studies are being conducted as to their efficiency as a control measure.

(3) A limited bait pail experiment showed that baits with ethyl cinnamate were not effective in trapping adult codling moths.

(4) No parasite or light trap studies.

III. Residue and its removal.

A. Due to the limited spray schedule used generally in Ohio, the residue situation has not become acute. The work with residue removal has been done largely by the Department of Horticulture of the Experiment Station and of Ohio State University. It has consisted mostly of sampling for determinations rather than research for new methods, materials, etc.

B. (1) Probably less than 5% of apple acreage is equipped for washing.

(2) Most machines in the State are flood type washer.

(3) Those growers equipped with washers have been generally quite successful in residue removal, although there has been one seizure this season.

IV. Recommendations for next year have not been developed at the present date.

- - - - -

OREGON

D. C. Mote, B. G. Thompson, and R. H. Robinson. Oregon Agricultural Experiment Station, Corvallis.

I. Seasonal conditions and codling moth abundance during the 1934 season:

The seasonal history was rather unusual this year. Moths were present in the orchard at the time the calyx spray was applied on April 18. A peak of the first brood was reached on May 14. From this date on until the middle of August the flight was unusually light with numerous small peaks.

On August 22 a peak of the second brood was reached with the largest flight of the season. It was from this flight of moths that the greatest worm injury was obtained. Up until this flight the orchards of the Willamette Valley that had been following the spray schedule were unusually free of worms.

II-A. Control by insecticides

Codling moth spray tests were conducted in the Central Willamette Valley, at Monroe, Oregon. The same methods of applications, spray rigs, etc., were used as in previous years. Ten trees were used in each test and all the fruit, including windfalls, were examined, as in previous years. Two varieties, Ortleys and Newtowns, were available for these tests. Due to the unusual season, four cover sprays were applied.

The sprays were applied on the following dates:

Calyx spray - - - - - - - - - - - - - - - - -	April 17
First cover spray - - - - - - - - - - - - - -	May 17
Second cover spray - - - - - - - - - - - - -	June 15
Third cover spray - - - - - - - - - - - - - -	July 20
Fourth cover spray - - - - - - - - - - - - -	August 23

The sprays applied, and the resulting percentages of clean fruit, are given in the following table:

Plat No.	Treatment	% of clean fruit
1	Lead arsenate check 3# to 100 gallons	89.07
2	Manganar 3# to 100 gallons plus 1/2 pint fish oil	64.65
3	Unsprayed check	17.29
4	Dutox 3# plus 1/2 pint fish oil	74.56
6	3# Dutox plus 3/4% oil No. 6	74.09
7	Calcium arsenate 3# plus aluminum sulfate, 1 lb. to 100 gallons	97.79
8	Calcium arsenate 3# plus zinc sulfate, 1# to 100 gallons	98
9	Calcium arsenate 5# plus zinc sulfate 1/4# plus 1/2# lime to 100 gallons	95.55
10	Calcium arsenate 3# plus aluminum sulfate 1# plus 1 pint Black Leaf 40 (no Black Leaf 40 in calyx) to 100 gallons	97.23
12	3 quarts of oil No. 6 to 100 gallons plus 1 pint Black Leaf 40 in last three covers. Calcium arsenate 3# to 100 in calyx and first cover	71.27
14	Rotenone in last three covers; calcium arsenate in calyx and first cover.	71.76
15	Rotenone plus 3/4% oil No. 6 in last three covers; calcium arsenate 3# to 100 gallons in calyx and first cover	78.41
16	Calcium arsenate 3# to 100 gallons	92.67

Considerable spray injury was obtained in all fish oil plats.

Some injury obtained in mineral oil plats.

II. Results of experimental work.

B. Control by means other than spraying.

(1) Bands

(a) Chemically treated.

For the third successive year a block of approximately eleven acres of apple trees were scraped and banded with beta-naphthol treated bands. This block was in the corner of a 160-acre tract. Both the banded and unbanded area were sprayed with calcium arsenate at the rate of 3# to 100 gallons. The regular spray calendar of a calyx and 4 cover sprays was followed.

Eight trees in that part of the banded block farthest from the unbanded area were selected at random and the fruit examined for worms. All the fruit of each of the 8 trees, including windfalls, was examined. Six trees from the unbanded area selected at random were used as a check with the following results:

	Clean	Wormy	Stings	% Clean
Banded	5500	46	34	98
Unbanded	2909	76	104	94.2

The plots contained two varieties of apples, Delicious and Newtowns.

III. SPRAY RESIDUE AND ITS REMOVAL

by

R. H. Robinson

A. Results of Experiments with Residue Removal

(1) Removal of lead and arsenic: (a) Numerous solutions and combinations of solutions have been used in experimental tests. These comprise hydrochloric acid, nitric acid, sodium silicate, sodium carbonate, sodium hydroxide, and several commercial solvents of varying compositions. Results indicated that among the various solvents tested none showed superiority to hydrochloric acid and sodium silicate. In order to increase the effectiveness of either or both of these solvents, many salt combinations, and supplementary organic solvents were added to both the hydrochloric acid and to the sodium silicate, depending upon promise of increased effectiveness indicated by laboratory studies of increased solvent action on lead arsenate. Various salts were used, such as sodium chloride, sodium nitrate, ferric nitrate, and other chemicals. Supplementary organic solvents added to either sodium silicate or hydrochloric acid included kerosene, light petroleum oil, denatured alcohol, acetone, and certain mixed organic solvents.

(b) The type of machinery used comprised commercial equipment of both flood and spray types, and the home built flotation type washer, such as the Oregon fruit washer. The commercial flood washer used in experimental studies was further modified by incorporation of brushes, including Tampico bristles, velour covered rolls, and rubber finger brushes. Tests also were made including the above-mentioned brushes altered to make the brushes oscillate laterally.

(c) Heating of solutions is important and necessary for the effective cleaning of all apples, except very lightly sprayed fruit that is washed immediately after harvest. Temperature control is perhaps the most important influencing factor, since fruit unprotected by wax or oil and in a turgid condition is injured by comparatively low temperatures, whereas very waxy fruit or heavily oiled fruit that has been allowed to stand in common storage for a few days before washing, may be put through solutions heated as high as 120° F. and even higher without causing injury. Heating of solutions, therefore, must be adjusted to the condition of the fruit, variety, and spray residue load present.

(2) No experimental studies have been made for the removal of fluorine compounds. Since fluorine compounds are not as effective as lead arsenate for control of the codling moth, and because it is practically as difficult, if not more so, to remove this element below the established tolerance of .01 grains per pound, we advise strongly against the use of fluorine sprays for codling moth control. Consequently, practically none is used in Oregon for this purpose. No experimental work, therefore, has been carried on for the removal of fluroine residue.

B. Growers' Experiences with Spray Residue Removal

(1) Estimating approximately, more than 95% of the apple and pear acreage is equipped for washing. Most of the fruit, however, is processed through association or commercial packers, who maintain their washing machine and packing equipment at centralized places.

(2) The type of machinery used comprises the various commercial washing equipment, such as Cutler fruit washer, Bean fruit washer, Ideal fruit washer, and the Wuest flotation type washer. In addition, scattered throughout the fruit district, are a few homemade flotation type washers patterned after the Oregon washer.

(3) Fair success has been obtained in cleaning both apples and pears effectively below the established tolerances. Arsenic is no longer a problem. The Chemistry Division of the Oregon Experiment Station endeavors to service the industry by helping in every way possible when difficulty is encountered in the fruit washing process. About 98% of the fruit is cleaned without a rewash. Occasionally a grower will apply an oil spray a few weeks before harvest, in which event it is practically impossible to remove the residue below the tolerance. This, however, depends upon the lead residue load and the variety of fruit to be washed.

Supplementary Comments.

When it is considered that the fruit washing process is a chemical one wherein personal judgment must be exercised in the modification of the solvent used, adjustment of temperatures and regulation of the concentration of the solvent, progress in the removal of the lead residue during the past two seasons, has been very encouraging. It is essential that the orchardist adhere to a spray schedule recommended by proper authority if the fruit is to be cleaned below the tolerance without severe loss because of injury caused by the processing of fruit difficult to clean. Where climatic conditions are favorable to a heavy codling moth infestation and

a heavy schedule, including two or three oil-lead combination sprays, must be used, effective cleaning is difficult and the margin between the harsh washing treatment and injury caused by this treatment to the fruit, is very narrow. Observations made by me during visits to the principal fruit districts of Oregon, Washington, and Idaho this fall convinced me that every point the lead residue tolerance is lowered will make it more than doubly difficult to clean apples effectively below it. For those orchardists, in districts that require a heavy spray schedule, who resort to abnormal spray combinations, a lowering of the tolerance will condemn their fruit to the vinegar or pectin factory. At present, replacement of washing equipment designed primarily for the removal of arsenical residue is most important in those districts where fruit is difficult to clean. Many orchardists in the Pacific Northwest this season have had to take their fruit to the commercial packer who has installed up-to-date washing machines, in order to get their fruit by the tolerance. This is costly to the orchardist, and a better understanding of the washing process as it applies to lead removal would have enabled him to clean his own fruit.

OREGON

Leroy Childs, Hood River Branch Experiment Station, Hood River.

Investigation of the more promising insecticides for codling moth control was continued at the Hood River Station during 1934. This included the study of calcium arsenate with and without oil, zinc arsenite, and arsenate, and natural cryolite. During the 1933 season, noticeable foliage injury occurred in all the plots where arsenical substitutes were employed. During the past season so-called buffers including both aluminum sulphate and zinc sulphate were used with these arsenicals and it was observed that no injury followed their usage throughout the season. Insofar as these arsenical substitutes are concerned, it may be stated that they are not as effective as arsenate of lead, the latter appearing to give from two to three times better control. Where worm conditions are not serious as was the case in the orchard where these tests have been made, it might be possible to substitute either calcium or zinc arsenate in some of the later sprays if the residue problem is such that tolerances cannot be met. However, for the present it seems inadvisable to make such recommendations until further tests have been made owing to the fact that there still remains a possibility of injury occurring under certain unknown climatic conditions.

Natural cryolite was used in three different combinations, that is, alone, with 1 quart of mineral oil to 100 gallons, and 1 pint of fish oil to 100 gallons of spray. In our tests this year, Kaylo used alone permitted worminess of the same degree as when combined with the oils although total worm damage was somewhat greater in the lots where the cryolite was used alone. On the Newtown apples, the cryolite apparently causes some injury which appears on the foliage in the form of a mosaic-like coloring of the leaves. This has been observed for the past two seasons to be more noticeable where fish oil is combined with the insecticide than is the case with cryolite alone or in combination with mineral oil. Cryolite also affects the fruit slightly in that it does not possess the excellent finish that follows the use of arsenate of

lead. The natural russet that occurs on Newtowns seems to be somewhat accentuated, a condition which becomes more noticeable as harvest is delayed.

In studying tables, Experiments 18, 19, 27, and 28 cannot be directly compared with the other tests. This group of tests was not conducted in replicates, but consisted of a group of four trees in a different part of the orchard, counts, however, being taken from all four trees in the regular manner.

CODLING MOTH TESTS - 1934
Hood River Experiment Station
Average Worm Damage in Replicates

Leroy Childs — Hood River, Oregon

Exp. No.	Material Used	% Worms	% Stings	Total % Damage
18	Cal. Ars. 3-100 plus 1% #4 Oil - regular (2)	3.20	4.53	7.33
19	Cal. Ars. 3-100 Zn. Sul. 1-100 Cal. Hyd. 2-100 (1)	3.30	8.20	11.20
27	Ars. L. 3-100 1% E 548 Shell (3)	.93	5.60	6.53
28	Ars. L. 3-100 plus Dolmanite Soap ¼-100	1.06	5.46	6.40
20	Zinc Arsenite 3-100 Zinc Sulphate 1-100 Cal. Hyd. 2-100 (1)	3.80	7.0	10.10
21	Cal. Ars. 3-100 Alum. Sul. 1-100 Hyd. Lime 2-100	2.60	6.90	8.00
22	Zn. Arsenite 3-100 Alum. Sul. 1-100 Cal. Hyd. 2-100	1.00	6.30	6.80
23	Zn. Arsenate 3-100 Z. Sul. ¼# ¼-100 Cal. Hyd. ½-100	3.40	6.10	8.60
24	Kaylo 3-100 Fish Oil 1pt-100	2.40	5.90	8.00
25	Kaylo 3-100 Min. Oil #4 1qt-100	2.60	6.20	8.40
26	Kaylo 3-100	2.00	9.10	10.30
Check	No Spray Replicate 3 only	20.90	5.80	24.70

(1) Sprayed in calyx and throughout season as outlined. Other tests all sprayed in calyx with lead arsenate.

(2) Severe oil injury, oil dropped in 4th and 5th cover, sprayed as in 19.

(3) Oil dropped in all plots in 5th cover because of injury except experiments 24 and 25.

OREGON

L. G. Gentner, Southern Oregon Branch Experiment Station, Talent.

I. Seasonal Conditions and Codling Moth Abundance -

The 1934 codling moth season was an unusually early and long one. It was necessary to apply a calyx and eight cover sprays on apples, where normally a calyx and only five or six cover sprays are necessary. On pears five or six cover sprays were used instead of the usual three or four.

The first moths were trapped on April 6, whereas the earliest catch recorded in the preceding six years was on April 26. There were continuous catches, approaching a peak, until April 22. A ten-day period of cool weather followed with very little flight. During May, June, and July there were numerous interruptions of codling moth activities due to unfavorable weather conditions. The peak flight of spring brood moths occurred in some orchards on May 13 and in others on May 22. There were very high catches on both nights, with cool weather intervening. There was no definite break between first and second-brood activities. Many of the spring-brood moths were still flying when the earliest moths from first-brood larvae began to appear. The peak flight of moths from first-brood larvae occurred July 20, and from second-brood larvae August 23. Throughout August and the first part of September, codling moth flights were heavy and not interrupted by weather conditions.

II. Results of Experimental Work.

A. Control by insecticides.

(1) Lead arsenate - percentage of wormy fruit somewhat higher than average, because of codling moth abundance.

(2) Non-lead arsenicals-

(a) Calcium arsenate, 3-100, with 2 pounds hydrated lime and 1 pound zinc sulphate gave poorer control on Anjou pears than lead arsenate.

(3) Fluorine compounds-

(a) Kalo, 3-100, with 1 quart commercial oil emulsion gave somewhat better control than lead arsenate.

(4) Other inorganic materials.

(5) Organic materials-

(a) Oil-nicotine, 1-1200, with $\frac{1}{2}$% summer oil, in all but the calyx and first cover sprays gave better control on Bartlett pears than lead arsenate.

(b) Nicotine tannate

(c) Derris root with kaolin, 1% rotenone, (calyx and first cover lead arsenate), 5 and 10 pounds-100 gallons, both with and without oil, gave much poorer control than lead arsenate, on pears.

(d) Pyrethrum with kaolin, .25% pyrethrins, 10-100, with ½% summer oil, at seven-day intervals, (calyx and first cover of lead arsenate) gave about as good control as lead arsenate on Bartlett pears.

(e) Nicotine-bentonite (8%), 3-100, with ½% summer oil (calyx and first cover of lead arsenate) gave control about as lead arsenate on Bartlett pears. Without the oil the control was much poorer.

Nicotine-bentonite (8%), 6-100, alone, at seven-day intervals (calyx and first cover of lead arsenate) gave control about as lead arsenate. At the regular timing the control was much poorer.

(f) Cube root with kaolin, 1% rotenone, 10-100, at seven-day intervals (calyx and first cover of lead arsenate) gave much poorer control than lead arsenate on Bartlett pears.

No burning or injury of any consequence occurred on foliage or fruit of apples and pears from the use of any of the above materials. There was an occasional slight calyx burn on Newtown apples from the use of an oil-lead arsenate combination in the second and third cover sprays.

B. Control by other means than spraying-

(1) Bands - heavy grade corrugated paper, treated with beta naphthol-oil. Tests in previous years have shown them to be of decided value in reducing an infestation in an orchard, where the loose bark has been scraped from trunk and bases of large branches.

(2) Sanitation

(3) Bait traps, when properly taken care of, are a valuable indicator for timing of sprays.

III. <u>Residue and its Removal</u>.

A. Results of experiments with residue removal.
(Analyses by R. H. Robinson, Chemist, Oregon Experiment Station, Corvallis, Oregon).

(1) Removal of lead arsenate.

(a) Solutions used - hydrochloric acid wash.

(b) Types of machinery - Bean washer.

(c) Heating solutions - to 100° F. for Newtown apples, 80° F. for Bartlett pears, unheated (65° F.) for Bosc and Anjou pears.

An acid bath of 2.77% at 100° F. removed the lead to .014 or less, even where a calyx and eight covers of lead arsenate, with

an oil-lead arsenate combination in 2, 3, 5 were used.

A 2.5% acid bath, unheated, removed the lead to .0170 grains per pound or much less, on Anjou pears that had received a calyx and five covers of 3 pounds of lead arsenate and an oil application for mite control. Where three oil applications were used the residue was .0217 after washing.

On Bosc pears, a 2.5% acid bath, unheated removed the lead to .008 grains or less. These pears received a calyx and five covers of lead arsenate, but no oil.

A 1.5% acid bath at 80° F. removed the lead to .0108 grains on Bartlett pears receiving a calyx and five covers, even where an oil-lead arsenate combination was used in 2, 3.

A calyx and first cover spray of lead arsenate, 3-100, may leave a lead residue at harvest on unwashed fruit, of more than .014 grains per pound.

B. Growers' experience with residue removal.

(1) Proportion of acreage equipped for washing -

Practically all of the commercially packed fruit is washed and packed at packing houses.

(2) Type of machinery used -

With few exceptions all packing houses are equipped with Bean washers, using an acid wash.

(3) Degree of success in residue removal -

With a few exceptions there was no difficulty in removing the lead deposit to within the tolerance.

IV. Lead Arsenate Will Still be Recommended as the standard insecticide for controlling codling moth, with an oil-lead arsenate combination in the second and third cover sprays on apples. Timing of sprays to be according to notices based on catches in bait pans. Scraping and banding of trees is recommended for apple trees and pear trees where there is an unusually heavy infestation.

- - - - -

PENNSYLVANIA

H. N. Worthley, Pennsylvania Agricultural Experiment Station, State College.

I. Seasonal conditions and codling moth abundance during the 1934 season.-

In the heavily infested area composed of parts of York, Adams, and Franklin Counties (the upper end of the Cumberland-Shenandoah region) winter carryover of larvae was heavy, due to an abbreviated spraying schedule employed in 1933. Moth emergence began on May 14 at Biglerville in Adams County, one day earlier than in 1933. The first peak flight came on May 21, a week earlier than in 1933. Following peaks were scattered through the warm spells in June, and emergence of the overwintered generation was over by July 7. First brood emergence began July 3 and was practically ended by August 26, with just a few stragglers coming along until September 17. First brood moths were abundant only from July 18 to July 23, and August 1 to 7. Attack by the second brood of larvae was much lighter than in 1933, for three reasons. First, conditions for moth flight, egg-laying, and survival of newly-hatched larvae were unfavorable during late July and early August; second, the more extended spraying schedule employed in 1934 gave much better protection; third, the use of chemically treated bands was general in this section, and kept emergence of first brood moths to a minimum.

II. Results of experimental work.

A. Control by insecticides.

Control plots were laid out either in a Latin Square or in randomized blocks, and we attach considerable significance to the results obtained. (Only Jonathan results ready.)

(1) Lead arsenate.

In 1933 a petal fall and 3 cover sprays gave 90% injured fruit and 70 worms per 100 apples. In 1934 a petal fall and 8 cover sprays gave 42% injured fruit and 4.4 worms per hundred apples, most of the injury consisting of stings. Five of the cover sprays contained lime sulphur, with the result that 56% of the fruit showed various degrees of spray russet. Leaf drop, while not serious, was quite noticeable.

(2) Non-lead arsenicals.

Calcium arsenate plus summer oil (0.5%) replaced lead arsenate in first 3 cover sprays, and was followed by 5 cover sprays of summer oil (1%) and nicotine sulphate. Sodium polysulfide in 4 sprays. 44% injured fruit, 25 worms per 100 apples, 54% of fruit spray burned. Much of this was in the form of a sunken, black ring about the calyx, much different and much more serious than with lead arsenate. Leaf drop was heavy.

(5) (a) Oil-nicotine.

Lead arsenate in the first 2 cover sprays was followed by nicotine sulphate (3/4 pint-100 gals.) plus 1% summer oil in 6 cover sprays. Coposil was used in 4 sprays. 20% injured fruit, 13 worms per

100 apples, 58% of the fruit spray burned. This burning was largely a slight netted russet, not serious. It occurred late, and seemed a cumulative effect of oil-Coposil.

(5) (e) Other organic materials.

Black-leaf 40, Kolofog, S.A.S. spreader in 8 cover sprays. 39% injured fruit, 33 worms per hundred apples, 13% fruit spray burned. This combination had too little stomach poison effect, though stinging was much reduced. The trees were not adversely affected by the spray, but Kolofog plastered the apples to such an extent that it was not removed by washing, and interfered with sale of the fruit in the New York market.

Black-leaf 155 plus flotation sulphur in 8 cover sprays. 37% injured fruit, 39 worms per hundred apples, 30% fruit spray burned. Stomach poison effect lacking, though stinging effectively reduced. Spray russet not serious, and as in Kolofog treatment appearing to be a cumulative effect of continued spraying in hot weather. Tree condition excellent.

Results on Rome Beauty are not yet summarized. It is expected that they will confirm the Jonathan experiments, though showing less infestation and less spray injury. Results with various combination containing lead arsenate on Grimes are not yet available.

B. Control by means other than spraying.

(1) Bands.

Through previous experiments have settled on chemically treated bands. Tested various commercial bands in 1934. Good control by spraying in orchard used (a big surprise after 1933) gave small catch of larvae in bands. Results not summarized. Wide differences not expected. Convinced that weight of chemical per roll of band not a good criterion. Too easy for manufacturer to attain standard by pouring mix over light band, thus clogging tunnels. Manufacturing process should be subject to inspection under the Public Service Patent. Too many concerns putting out bands merely to match competitors.

(3) Bait trap studies.

Using Brer Rabbit Green Label molasses, 1-10, in No. 10 cans hung in the tops of apple trees as a standard for comparison, and treating the catch in this set-up as 100, other set-ups ranked as follows: (5 pails in each series, rotated in circle)

Brer Rabbit, 1-10, No. 10 cans	100
Brer Rabbit, 1-20, No. 10 cans	90
Bright light refiners' syrup, 1-20, No. 10 cans	44
Brer Rabbit, 1-20, +1 cc Anethol per No. 10 can	117
Brer Rabbit, 1-20, +1 cc Citral per No. 10 can	104
Brer Rabbit, 1-20, No. 10 cans with baffles 4" high at right angles above rim	120
Brer Rabbit, 1-20, in tin pans 12" diam. and 4" deep	88

These preliminary experiments suggest that the catch in bait pails can be increased by adding Anethol as an attrahent, and providing the pails with baffles. The tin pans, while they increased the trapping surface of the bait, were difficult to handle, and much more subject to spilling in wind.

(4) Light traps.

Preliminary tests were made in duplicate, traps revolving one tree in circle each day. Light source in all cases 75-watt inside frosted Mazda. Brer Rabbit, 1-10, in No. 10 can without light or reflector, used as standard of comparison, and catch rated here at 100. One tree interval between traps, lighted traps alternated with unlighted, to give equal direct competition.

Series I. May 20 - Aug. 3.

Brer Rabbit, 1-10, #10 can, no light, no reflector	100
Brer Rabbit, 1-10, + Anethol, as above	423
Brer Rabbit, 1-10, #10 can, no light, reflector	215
Brer Rabbit, 1-10, #10 can, light, reflector	1300
Water alone, #10 can, light, reflector	1023
Electrocuting light trap	2654

Series II. Aug. 4 - Sept. 9.

Brer Rabbit, 1-10, #10 can, no light, no reflector	100
Brer Rabbit, 1-10, 12" diam. pan, no light, no reflector	143
Brer Rabbit, 1-10, 12" diam. pan, no light, reflector	57
Brer Rabbit, 1-10, 12" diam. pan, light, reflector	1143
Water alone, 12" diam. pan, light, reflector	1657
Electrocuting light trap	671

These preliminary tests suggest light to be a much better trapping agent than bait. Superiority of electrocuting trap over simple water trap below light not clearly evident. Application to packing shed sanitation indicated. Application to orchard practice needs study.

III. Residue and its removal.

A. Results of experiments with residue removal.

(1) Removal of lead and arsenic.

Lead removal was more of a problem than arsenic. The basic solution was 1% cold hydrochloric acid. Resistant samples were sent through stronger acid, up to 2.5%, in flotation and underbrush machines. Lots resisting acid alone were not cleaned below tolerance by the addition of various materials, such as salt, Vatsol, Areskap, Aresket, etc., in cold solution, nor in solutions heated to approximately 100° F. Increasing the time of exposure in flotation machines did not increase the effectiveness of wetting agents. It is not clear that the underbrush machine is superior to the flotation type, although heated solutions were more effective in the former. The use of heated acid solutions, rather than the addition of wetting agents, seems indicated. BW silicate, 80 lbs. to 100 gals., at 100° F., was little better than cold 1% HCl.

The tentative statements above are based on figures for lead alone; not all the arsenic determinations have been made. These statements may need some modification after critical study of all the figures.

B. Growers' experiences with residue removal.

(1) Proportion of acreage equipped for washing. This is rather difficult to estimate. In 1933 there were only three washers in the State. Quite a few were installed in 1934, some by individuals, others by packing companies. In both Franklin and Adams Counties probably 50% of the packed apples were washed in 1934, and more crops would have been washed had not analyses showed arsenic to be below the tolerance.

(2) Type of machinery in use. Two big Cutlers, one overhead flood, one or two Bean underbrush, and the rest Bean, Wayland, and home-made flotation machines.

(3) Degree of success in residue removal. In most cases successful. In three orchards, where spraying practice was unnecessarily severe in combating heavy infestations, residues resisted ordinary washing treatment, and heated solutions were finally employed.

IV. Recommendations proposed for the 1935 crop season.

This is the responsibility of the Extension entomologist. Exact procedure not yet settled. Four cover sprays for first brood will be employed, using lead arsenate (3-100) plus skim milk powder, with nicotine sulphate in one or two applications. Due to the great reduction in infestation in 1934 it is felt that this will meet most needs. Second-brood sprays, where necessary, may be lead arsenate alone, or possibly oil-nicotine. Scraping and banding will be strongly recommended. Unless there is some change in regulations, the necessity for washing will be indicated for crops receiving the full schedule.

I am sorry that complete summaries are not available, but I feel that the general statements made here will be subject only to minor revision.

- - - - -

UTAH

C. J. Sorenson, Utah Agricultural Experiment Station, Logan.

With respect to codling moth research I regret to say that we have had no project work on this subject for a number of years, hence, have no results to report.

The codling moth situation in this State during the past season, which was unusually long and dry, was more serious than average. General observations of codling moth infestations indicate that there was almost a continuous brood throughout the summer, resulting apparently in the production of an extra brood.

Although a careful survey has not been made, it is our opinion that not more than about one-half of the apple and pear acreage is equipped with washing machinery. There are a few commercial types of washers used, but the majority are home-made dipping tanks.

The consensus of sentiment among apple and pear growers is rather antagonistic to the regulations with respect to spray residue removal.

- - - - - - -

VIRGINIA

A. H. Teske and W. J. Schoene, Virginia Polytechnic Institute, Blacksburg.

In the following table are given the data on an orchard experiment in which Orthol K or summer Scalecide was combined in the regular spray schedule. The orchard contained 575 trees ranging in age from 20 to 45 years and were mostly the York variety. They were heavily loaded with fruit. The orchard had suffered from severe losses due to codling moth in 1933. The results reported in the following table shows that the principal damage this year was due to stings. The percentage of worms was checked at harvest time only. There was no injury either to fruit or foliage in any of these spray blocks and the residue in all cases was readily removed when the apples were passed through a flotation washer without heating the bath. The Coposil which was substituted for Bordeaux in Plot 2 was equally effective in holding scab and other diseases in check.

Results of Spray Experiment in 1934

Plat No.	Spray Program	% Worms	% Stings	Arsenic	Lead
1	1st cover, lead, 2nd & 3rd, Scalecide 3 qts., & lead, 4th, lead 5th, Scalecide and Nicotine 1-800; 6th, Orthol K 1%, Nicotine 1-1200	1.6	49	.021	.034
2	1st cover, lead; 2nd & 3rd, lead and Orthol K 3 qts.; 4th, Lead 5th, Orthol K 3 qts. B.L. 155; 6th, Orthol K 1% & Nicotine 1-1200	1.8	55	.018	.031
3	1st cover, lead; 2nd & 3rd, Orthol K 3 qts. & Lead; 4th & 5th, Lead; 6th, unsprayed	.5	19	.022	.034
4	1st cover, lead; 2nd & 3rd, Orthol K 3 qts. & lead; 4th, lead 5th Orthol K 3 qts. & Nicotine 1-1200; 6th, unsprayed	.9	20	.017	.027
5	1st, 2nd, 3rd, & 4th cover, lead; 5th & 6th, Orthol K 3 qts. and nicotine 1-1200	1.7	40	.008	.012

Fungicide used with the above sprays as follows:

Lime sulphur was used in all plots in the petal-fall and first-cover sprays. In Plot 1 Bordeaux was combined in sprays, two to five inclusive. In Plot 2 Coposil was combined in sprays two, three and five and Bordeaux in fourth. In Plot 3 Bordeaux was combined in sprays two to five inclusive. Plot 4 the same. Plot 5 Bordeaux was combined with second and third cover.

Lead arsenate used three pounds to 100 gallons of spray.

VIRGINIA

W. J. Schoene and R. N. Jefferson, Virginia Agricultural Experiment Station, Blacksburg.

Laboratory tests were made with contact insecticides on eggs of the peach moth and the codling moth. The eggs of these two insects were affected in like manner with the sprays. In this series of tests, eggs of different ages were subjected to the insecticide in each case. It was found that when the spray combination was approximately 100 percent in effectiveness all eggs were killed regardless of age, whereas, if the combination tested was only partially effective, the results were very irregular. The 1 percent Orthol K emulsion at a temperature of 70° F. was effective for the eggs of both insects, whereas, the Black Leaf 40, 1-1200, plus Orthol K emulsion $\frac{3}{4}$ percent, was 100 percent effective for the peach moth. The Pyrethrum tested was not effective at nominal strength.

VIRGINIA

W. S. Hough, Winchester Research Laboratory, Virginia Agricultural Experiment Station, Winchester.

Results of orchard experiments for codling moth control, Winchester, Va.

Plot No.	Spray program and amount of insecticide per 100 gal.	Percent injury		Remarks on spray injury etc.
		York orchard	Ben Davis orchard	
	In calyx lead arsenate 3# in all plots except Nos. 2, 3, and 4			
1	Lead arsenate 3# 1st cover Nicotine bentonite 5# 2, 3, 4, 5, 6 covers Bordeaux 2, 4, 5th covers Oil $\frac{3}{4}$ gal. 2, 3, 4, 5, 6th covers except oil omitted in 3rd cover on Yorks	34.6	20.1	
2	Nicotine bentonite 5# calyx and 6 covers on Yorks, five covers on Bens	30.5	42.9	
3	Nicotine bentonite Bx 5# calyx and 6 covers on Yorks, five covers on Bens	50.8	63.3	
4	Nicotine bentonite Bx_2 5# calyx and 3 covers. Then changed to nicotine bentonite 5#, 3 covers Yorks, 2 covers Bens Oil 1 qt. in 6th cover on Yorks	35.3	68.4	
5	Lead arsenate 3#, 6 covers Yorks, 5 covers Bens plus oil 1 qt. in 2nd cover on Bens	19.1	11.5	Very severe arsenical injury on Ben Davis fruit & foliage
6	Lead arsenate 3# 1st cover then On Yorks: Cal. arsenate 3# in 5 covers plus oil 1 gal. 2, 3, 4, 6th covers On Bens: Cal. arsenate 3# in 4 covers plus oil 1 gal. 2, 4, 5th covers. Bordeaux in all cal. arsenate sprays	31.4	31.1	No injury of importance

Plot No.	Spray program and amount of insecticide per 100 gal.	Percent injury		Remarks on spray injury etc.
		York orchard	Ben Davis orchard	
7	Same materials throughout as in Plot 6, except fish oil 1 qt. substituted for mineral oil emulsion	61.2	65.2	No injury of importance but no control
8	Lead arsenate 3# 1st & 2nd covers On Yorks: natural cryolite 4# 4 covers On Bens: natural cryolite 4# 4 covers plus fish oil 1 qt. 3rd & 4th covers	27.6	12.7	Fruit & foliage on Bens in good condition
9	Lead arsenate 2# 1st & 2nd covers plus oil 1 gal. both orchards then On Yorks: lead arsenate 3# 4 covers On Bens: lead arsenate 3# 3 covers Bordeaux in 1st & 2nd covers	14.5	14.9	Fruit & foliage good condition both orchards
	Check, not sprayed	68.3	84.9	

Nicotine bentonite used contained 8% nicotine

Percent injury based on total yield of count trees including drops from July to October inclusive.

The oil-lead arsenate program of Plot 9 gave the best results in both orchards when condition of fruit, foliage, and codling moth control are all taken into consideration.

The split schedule of lead arsenate-cryolite used in the Ben Davis orchard gave equally satisfactory results. The omission of the fish oil in all cryolite sprays in the York orchard resulted in increased codling moth injury.

The nicotine bentonite and Bordeaux (copper sulphate 2 lbs. lime 6 lbs. per 100 gal.) killed codling moths as used in Plot 1. It appears that the nicotine compound in the presence of an alkaline medium liberated sufficient nicotine to kill most of the moths in the trees at the time of the application. A partial summary of data on killing codling moths with nicotine, see note Jour. Econ. Ent. Vol. 27, No. 5, p. 1102.

Residue on fruit picked from each plot in which an arsenical or cryolite was used one or more times follows:

(Fruit picked in October)

Plot number	Gr./lb. Yorks			Gr./lb. Ben Davis		
	As_2O_3	Pb	F_2	As_2O_3	Pb	F_2
1	.009	.015		.009	.010	
5	.084	.180		.052	.100	
6	.117	.022		.060	.012	
7	.067	.016		.049	.014	
8	.016	.023	.051	.013	.019	.040
9	.080	.136		.055	.090	

Residue removal.--The fluorine residue on the Ben Davis apples was reduced to a point well within the fluorine tolerance (.01 gr./lb.) when the fruit was washed in flotation washers using HCL 1% to 1.5% and heated to 110°. Minimum time in acid bath 45 seconds. Wiping the fruit was ineffective and cold HCL did not always clean the fruit within the fluorine tolerance.

Sodium silicate at the rate of 75 lbs. per 100 gallons in flotation washers was consistently much less effective in the removal of arsenic, lead and fluorine than HCL.

Fruit from plots 5 and 9 was cleaned within the present lead and arsenical tolerances in flotation washers using HCL 1% and heated to 110°, exposure in wash 45 seconds. It was necessary, however, to add a detergent ($\frac{1}{2}$%) to clean the fruit within the proposed .014 gr./lb. of lead.

Approximately 40% of the 1934 apple crop in northern Virginia was washed. All types of washers were used, from home-made flotation washers to the late model brush washer. No difficulty was encountered in removal of lead and arsenic residues, although most of the leading growers found it advisable to heat the acid solution. Injection of steam into the acid bath is the most common method of heating; some use steam pipes or hot water pipes in the acid bath.

Recommendations for 1935.--No important change from the 1934 recommendations of lead arsenate for both first and second broods of the codling moth. It is proposed to advise the use of summer oil emulsion 1% in two of the critical cover sprays for first brood control.

- - - - -

WASHINGTON

James Marshall and R. L. Webster, Wenatchee Field Laboratory, Wenatchee, and Washington Agricultural Experiment Station, Pullman.

I. Seasonal Conditions and Codling Moth Abundance in 1934.

A mild winter, coupled with an early spring, was particularly favorable to the codling moth. The season of 1934 was characterized by a very early codling moth emergence and almost uninterrupted egg depositions, which lasted from early May until late September. As a result codling moth control was far more difficult than usual. In spite of the application of more than the usual number of course sprays, worm loss was much greater than usual. There will be an unusually heavy carry-over of larvae for the season of 1935, unless winter temperatures go much lower than in recent years.

II. Results of Experimental Work.

A. Control by Insecticides.

1. Lead Arsenate. Control with lead arsenate was less effective than any time in the past nine years. In the lower irrigated valleys of eastern Washington, as a general rule, lead arsenate alone even at 3 pounds per 100 gallons of water was no longer sufficient to hold the codling moth in check. During 1934 there were many instances when even the addition of fish oil, soaps, or other spreaders or stickers failed to give satisfactory results. There were, likewise, many instances in which as many as four mineral oil sprays were applied in combination with lead arsenate and on occasion supplemented by five or six additional

applications of lead arsenate with spreaders, where control was likewise far from satisfactory.

Our investigations have indicated that the ammonium caseinate-summer oil emulsion did not accomplish effective codling moth control in the areas of most severe infestation. Emulsification of the oil by means of oleic acid and a suitable base, preferably organic in nature, has been found to be much more effective. Lead arsenate spray mixtures containing in addition to the arsenical, either fish oil, summer oil, or kerosene together with a suitable soap, have been consistently superior to any other spray combinations in codling moth control. There are difficulties with these soap-oil-lead arsenate mixtures. They have tended to cause arsenical injury, have presented certain difficulties in residue removal, and have been prone to cause trouble in mixing.

Experiments conducted by the Washington Experiment Station at the experimental orchard at Monitor, in the Wenatchee Valley, have shown that an organic base soap such as triethanolamine oleate is less troublesome to handle than most other soaps and is less likely to give rise to arsenical injury. It has been demonstrated that the soap-oil-lead arsenate mixture possesses characteristics obtained in no other spray combination so far examined. There are: the production of a uniform deposit of lead arsenate coupled with a progressive increase in the quantitative nature of the deposit which within the limits examined, appears to be a function of the time interval involved in application.

2. Non-Lead Arsenicals. Work of the Experiment Station during 1933 indicated that a number of non-lead arsenicals previously held to be unsafe for application upon deciduous trees could be prevented from producing arsenical injury in arid regions. The work of 1933 likewise indicated that non-lead arsenicals, particularly calcium arsenate, applied with a suitable buffer, might be expected to give fairly satisfactory codling moth control. Experimental work in 1934 conducted on an increased scale, five acres of orchard being involved in the experiments, has satisfactorily confirmed previous beliefs in these connections. A third year will be required in order that sufficient additional confirmation be obtained to justify definite recommendations.

3. Fluorine Compounds. Owing to the attitude of the Food and Drug Administration on fluorine residue, no experimental work was undertaken on fluorine compounds in 1934. This material was used to a limited extent by growers in two, sometimes three, cover sprays. At the present time not less than 50 carloads of apples are being held up by the Food and Drug Administration on account of fluorine residue.

4. Other Inorganic Materials.

5. Oil-Nicotine. Nicotine sulphate 40%, 1:1000, when used in combination with three-fourths gallon mineral oil in second-brood sprays only gave results approximating those obtained from the use of lead arsenate (3-100) alone. When the amount of oil was reduced to ¼% results were unsatisfactory. One-fourth percent herring oil substituted for mineral oil contrary to the previous year's indications was even less satisfactory than ¼% mineral oil. A complete tobacco extract, containing

9% alkaloid nicotine, with mineral oil certain definite proportions has shown some promise, but has not been examined with sufficient care to warrant definite conclusions.

6. <u>Pyrethrum</u>. Pyrethrum sprays were made from three different pyrethrum preparations, alcohol acetone extract (1% pyrethrins), pine oil extract of pyrethrum (2% pyrethrins), and finely ground pyrethrum flowers containing 1% pyrethrins. These preparations were used in a variety of ways under conditions of severe codling moth infestation. Some of the combinations were: pyrethrum with mineral oil from $\frac{1}{4}$% to $\frac{1}{2}$%, pyrethrum with herring oil $\frac{1}{4}$%, and pyrethrum extract with two antioxidants, phthalic acid and orthobenzyl paraminophenol.

The pyrethrum dosages were calculated on a cost basis to compare with nicotine sulphate 40% as a standard. The pyrethrin content of all spray mixtures was the same. No injury to fruit or foliage occurred but codling moth control was decidedly unsatisfactory in every case. It is possible that the pine oil extract might be used in cases of relatively low infestation but the cost factor might prevent this being economically sound.

B. <u>Residue and Its Removal</u>.

This subject will be dealt with in separate communications from the Divisions of Horticulture and Chemistry of the Washington Experiment Station.

C. <u>Recommendations Proposed for the 1935 Crop Season</u>.

Although no plans as to recommendations have yet been formulated, it is obvious that in the most severely infested areas lead arsenate in its most effective combinations must be used if satisfactory codling moth control is to be obtained.

- - - - -

WISCONSIN

C. L. Fluke, University of Wisconsin, Madison.

I. Exceedingly warm and dry May brought out moths much earlier than average but caused a sudden and nearly complete emergence within a few days. Sprays timed properly for this emergence gave excellent control. Weather nearly normal rest of season.

II. No experimental control. Lead arsenate recommended and used by most growers.

Bait traps used to determine spray dates.

III. <u>Residue</u>: Sodium silicate tested in three ways:

1. By dipping fruit into a bath of silicate at room temperatures, and used at 1-40, 50-100, 75-100, and 90-100 strengths; followed by an unheated water bath by dipping. Higher concentrations did not seem to increase efficiency enough to warrant their use.

2. By spraying fruit on trees with silicate at a 1-40 strength followed by a clear water spray. This method removed approximately 50% of both lead and arsenic.

3. Incorporating sodium silicate in the last regular spray at rate of 1-40. This facilitated removal of lead and arsenic when the fruit was later sprayed before picking, with clear water. It is assumed that tank removal methods would also be improved by adding the silicate in the last spray of lead arsenate.

This method caused a more rapid weathering of lead and arsenic although it appeared to become more effective in this way after several days - thus the fruit had ample protection from insect injury under Wisconsin conditions for the first week or ten days.

The simple method of adding sodium silicate to the last regular spray at the rate of 1 pound to 40 gallons of spray appears to be a desirable practice for fruit growers in sections where residues are only slightly above tolerance. It may also help in territories having excessive residues by increasing the efficiency of removal by the tank washing methods.

The silicate used in the experiments was the "BW" brand furnished by the Philadelphia Quartz Company.

- - - - -